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The impacts of river impoundment: a case study of H. Neely Henry Lake in northeast Alabama

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THE IMPACTS OF RIVER IMPOUNDMENT: A CASE STUDY OF H. NEELY HENRY LAKE IN NORTHEAST ALABAMA

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ABSTRACT

Dam building is one of the methods that modern civilization uses in an attempt to harness the power of nature. These dams and the impoundments associated with them can contribute numerous positive impacts to the surrounding human population. Unfortunately, there are negative impacts as well.

This research focuses on one impoundment in particular, H. Neely Henry Lake in northeast Alabama (an impoundment of the Coosa River). Site-specific information regarding the H. Neely Henry development is explored including area geography, history, and the formation of the Alabama Power Company – the agency responsible for H. Neely Henry and other Coosa River dams.

The benefits of H. Neely Henry dam are then evaluated. These include the availability of hydroelectric power, reduced flooding, and abundant recreational opportunities.

There was a significant impact on the human population associated with the region. Among other things, vast land loss occurred regarding the raising of the water level. Analysis was then conducted regarding the impoundment's effects upon the local population and economy. It is difficult to determine any impact the formation of H. Neely Henry Lake had on local population and economy.

Some positive environmental impacts of the impoundment include decreased flooding and increased habitat/food supply for some fish species. Some negative impacts include shoreline erosion, retention of upstream pollutants like PCB's, and decline of organisms requiring a free-flowing river to survive (particularly migratory fish).

A section analyzing related research is included which discusses the Tennessee-Tombigbee (Tenn-Tom) Waterway. The Tenn-Tom is a U.S. Army Corps of Engineers

impoundment system located in the same watershed. Also discussed in this section is the fight over water resources in the Coosa River between the states of Alabama and Georgia.

The overall results of the thesis are discussed including an evaluation of the NEPA process as it could relate to the Coosa River projects and the H. Neely Henry development specifically. Conclusions and recommendations follow. Among other things, it is suggested that Coosa River projects may have had a difficult time gaining acceptance if they had been subject to modern environmental statutes such as the Clean Water Act and NEPA.

CHAPTER 1

INTRODUCTION

Research Purpose/Problem Statement

> "Dams, and the water reservoirs they create, have historically been viewed as a benefit to society. River impoundments have provided comparatively cheap hydroelectric power, navigable waterways, flood control, agricultural irrigation, recreation, and diminished the occurrence of drought. Moreover, hydroelectric power is a clean renewable source of energy when compared with fossil fuel facilities that emit carbon dioxide, nitrous oxide, sulfurous oxides, and other air pollutants" (Saeger, 2006).

The process of impounding flowing bodies of water (rivers and streams) is one of the many ways that mankind has developed to seriously alter the course and landscape of the natural world. River impoundment, like many of the other methods, is performed for the benefit of human civilization. This research provides an analysis of an example of river impoundment, H. Neely Henry Lake located in northeast Alabama near the City of Gadsden. H. Neely Henry Lake is a portion of the once free-flowing Coosa River. The purpose of this project is to examine a multitude of impacts regarding the realized or potential effects of the impoundment of a once free-flowing river. These include economic, socio-cultural, environmental, and political aspects. The quote above gives an overview of the potential positive effects of dam building.

This research focuses on one particular river impoundment. It offers an examination and estimation of the impoundment's impacts on the surrounding region and the river itself. This examination of impacts may be useful to researchers and stakeholders interested in the long-term consequences of similar projects.

The impoundment of the Coosa River raised the water level in the area approximately 8 feet, permanently inundating dry or seasonally-flooded land; included in this research is an analysis of the impoundment's social and cultural impacts upon the human population, the local economy, and landowner compensation regarding the land loss associated with the impoundment and subsequent water-level rise. One of the main reasons for river impoundment is flood control – an analysis of the flood frequency before the impoundment and after the impoundment has been examined. Environmental impacts of impoundments are analyzed and related to the specific situation of H. Neely Henry Lake. Have the benefits outweighed the costs, or would it have been more beneficial to leave the Coosa River or potentially other bodies of water being considered for impoundment in their natural state? There are instances of river impoundment projects which have failed miserably and are considered a waste of money, materials, manpower, and a detriment to the environment - the Tennessee-Tombigbee (Tenn-Tom) Waterway located in west Alabama and northeast Mississippi is a glaring example of this (Passerini, 1982) (Phillips, 1982) (Watkins). More information on the Tenn-Tom Waterway can be found in Chapter 3 (Related Research) and Chapter 4 (Results and Findings). The H. Neely Henry development and other Coosa River projects preceded modern environmental statutes such as the National Environmental Policy Act (NEPA). Presently, NEPA is the standard by which the environmental effects of a project are measured. The Tenn-Tom Waterway was the first major water project to be subject to the rule of NEPA. One aspect of this thesis is to analyze the similarities and differences between the Tenn-Tom Waterway and the Coosa River dams and how they relate to the jurisdiction of NEPA (found in Chapter 4).

Overview of Area Geography

H. Neely Henry Lake is one of six impoundments of the Coosa River in the state of Alabama. The Coosa originates in northwest Georgia and meanders in a southwest direction into the state of Alabama. It connects with the Tallapoosa River near the town of Wetumpka, Alabama located in the east-central portion of the state. The union of these two rivers becomes the Alabama River which continues to flow southwest until it reaches the headwaters of Mobile Bay.

Figure 1: The Coosa River
Source: Coosa River, Wikipedia

H. Neely Henry Lake is located in portions of Etowah, St. Clair, Cherokee, and Calhoun Counties and is considered to be associated with the northern part of the Central Coosa River drainage basin. The lake is surrounded by numerous ridges which include Lookout Mountain and Dunaway Mountain. Upper portions of Dunaway and Lookout Mountains can exceed 1,000 feet above sea level in this area (this is fairly significant considering the elevation of the lake is just over 500 feet above sea level). This portion of the Coosa River experiences a significantly tortuous flow path with numerous large bends – most pronounced are Whorton Bend and Tidmore Bend (Alabama Power Company and Kleinschmidt Associates, 2000).

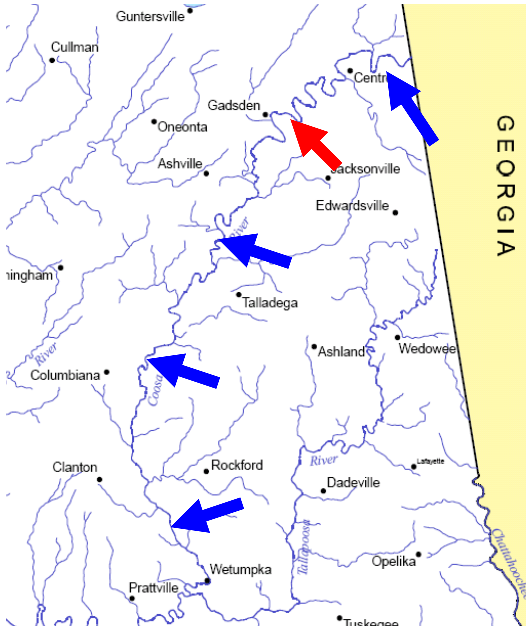

Figure 2: The Coosa River in Alabama (red arrow is H. Neely Henry Lake)
Source: Alabama Rivers, The Cartographic Research Lab, University of Alabama

In its location, the Coosa River is associated with a very unique geographical area. It is located in very close vicinity to three major physiographic regions of the eastern United States. The United States Geological Survey (USGS) defines physiographic regions as "broad-scale subdivision based on terrain, texture, rock type, and geologic structure and history" (Physiographic Regions). The Coosa River is primarily associated with the Valley and Ridge Province which can be considered the southern terminus of the Appalachian Mountains. This region is identified by long, continuous valleys bordered by even ridges (Ridge-and-Valley Appalachians). However, the Coosa is also associated with two other physiographic regions. To the northwest of the Valley and Ridge Province lies the Cumberland Plateau, this can be considered the southern part of the larger Appalachian Plateau. This region consists of a severely dissected plateau with elevation relief of approximately 400 feet. Bluffs and sandstone outcroppings are also numerous in this region (Cumberland Plateau). The Piedmont Upland region actually contains the southernmost reaches of the Coosa River before it joins the Tallapoosa River. The Piedmont Upland is characterized by somewhat low and rolling hills with elevations ranging from approximately 200 to 1,000 feet above sea level (Piedmont).

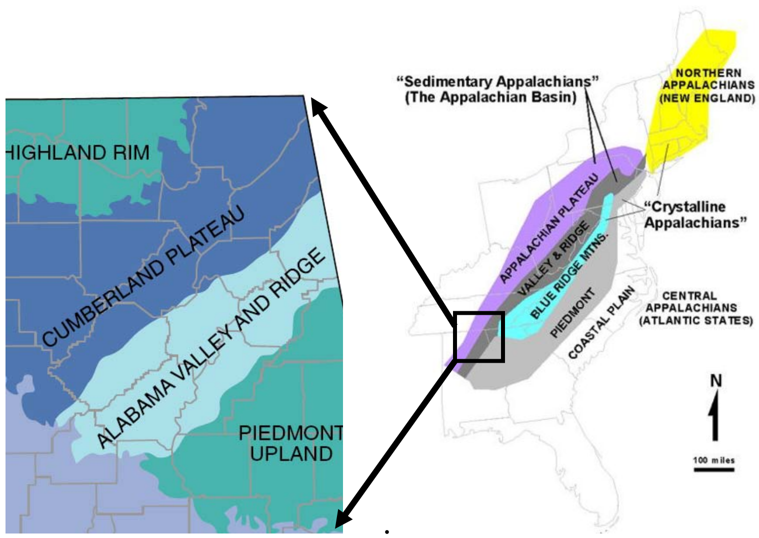

Figure 3: Some Physiographic Regions of the Eastern U.S.
Source: Appalachian Zones in the United States, USGS and Wikipedia
Inset: Northeast Portion of a Physiographic Map of Alabama
Source: General Physiography, The Department of Geography, University of Alabama

History of the H. Neely Henry Area and the Formation of Alabama Power

The Coosa Valley region associated with H. Neely Henry Lake is well documented to have experienced significant Native American settlement. This is especially true for what is known as the Historic period (AD 1500 – AD 1800). Around 1630 there is archaeological evidence of Native American settlement around the Whorton Bend area (Figure 5) – four sites in this area are considered villages. In approximately 1670, there is documentation of Native American settlement further downriver around

Woods Island (Woods Island is the modern location of H. Neely Henry Dam) (Figure 6). This settlement around Woods Island is believed to be the place where the local Native American population experienced the first contact with British traders (Alabama Power Company and Kleinschmidt Associates, 2000).

Beginning in the late 1600's until the early 1800's, the area was in a constant state of unrest as Native Americans, British, and French all vied for control of the region. Nearly constantly changing alliances between these powers was to blame, with British interests being expelled after the Revolutionary War, and French involvement generally being terminated with the Louisiana Purchase in 1803. Although the Alabama area was not part of the Louisiana Purchase, the U.S. did claim the port of Mobile which gave the U.S. sole ownership to the waterways used to access the interior lands of what would become the state of Alabama (Alabama Power and Kleinschmidt Associates, 2000). After the Louisiana Purchase, the issue of regional control resulted in conflict between the United States and Native Americans. In 1814, General Andrew Jackson defeated the Creek Indians at the Battle of Horseshoe Bend near present-day Dadeville, Alabama and many Creek lands were ceded to the United States. These lands composed about half of the Alabama territory which was formed in 1817. Alabama then achieved statehood in 1819 (Alabama Power Company and Kleinschmidt Associates, 2000).

From the beginning of statehood to the Civil War, the Coosa River developed into a viable shipping and transportation avenue, especially for the region's most lucrative crop – cotton. This was especially true immediately after the Civil War when river transportation was needed to replace the southern rail lines destroyed by the advancing Union Army (Coosa History). In 1887, the city of Gadsden had only five miles of railroad track usable for connection to the outside world. Thus the movement of any significant amount of freight was generally restricted to steamboat traffic on the river (Neville, 1966).

During pre-impoundment, the Coosa River was navigable from Rome, Georgia downstream to Greensport, Alabama just south of Gadsden (Neville, 1966). South of Greensport, however, downstream to Wetumpka were numerous impassable rocky shallows and rapids. If navigation from Greensport to Wetumpka was possible, the shipping could then continue to Mobile via the Alabama River which could open up vast possibilities for the region regarding commerce and trade. On several occasions, a system of locks and dams on this section of river was proposed. The Federal Government even initiated the project in 1889 and constructed three locks. The project was discontinued, however, due to questionable feasibility. The project would have required numerous additional locks to be constructed along with extensive dredging and other activities required for navigation which generated an unfavorable cost-benefit situation (Alabama Power Company and Kleinschmidt Associates, 2000).

In the late 1800's, a local entrepreneur and businessman, William Patrick Lay, became very interested in fostering a program which would harness the potential capabilities of the Coosa River - in particular, the potential for hydroelectric power through the construction of dams on the river. His ideas were met with interest from delegations from the state government, but no one took an initiative to create project plans or offer any public or private funding for the proposed action. Lay, his son, and his attorney incorporated Alabama Power Company in 1906 in an effort to jumpstart the project on their own. Over the years, Alabama Power would absorb smaller power companies and grow into the agency that was solely responsible for the construction and operation of impoundments on the Coosa River and for providing power for thousands of homes and businesses that are located in the region (Atkins, 2006).

Impoundment of the Coosa

In 1914, construction was completed on a dam at what was originally known as the Lock 12 site near the city of Clanton. It was eventually renamed Lay Dam for the founding father of Alabama Power Company. The creation of Lay Dam is the beginning of modern dam construction on the Coosa River and was the first major project for the infantile Alabama Power Company (Coosa Hydrologic Modifications). Lay Dam was redeveloped in the 1960's to coincide with the construction of the upper Coosa Dams which include H. Neely Henry Dam (Atkins, 2006) (Facts about Lay Dam). Lay Dam has a height of 129.6 feet which retains approximately 12,000 surface acres in the Lay Lake impoundment. The area of the watershed draining into the reservoir is about 9,087 square miles (Facts about Lay Dam).

Mitchell Dam was completed downstream of Lay Dam in 1923 (Mitchell Dam). The dam is named for James Mitchell, Alabama Power Company president from 1912 to 1920. It is located on the Coosa county/Chilton county border near the town of Verbena. Mitchell Dam has a height of 106 feet which retains about 5,850 surface acres in the Mitchell Lake impoundment. The watershed draining into Mitchell Lake is approximately 9,827 square miles (Facts about Mitchell Dam). Jordan Dam was constructed just upstream of Wetumpka in 1928 (Jordan Dam). This area is associated with the "Fall Line" of the United States which is the boundary between the coastal plain and upland areas (Atkins, 2006). Portions of rivers associated with the "Fall Line" generally have areas of extremely fast flowing water, shallow depths, and rocky rapids. Waterfalls are often associated with these areas as well. Pre-impoundment, the area of

Jordan Dam was known as the "Devil's Staircase" – a section of river well-known for its impassable rapids (Atkins, 2006) (Jordan Dam). Jordan Dam has a height of 125 feet which holds 6,800 surface acres in Jordan Lake. The watershed draining into Jordan Lake is about 10,165 square miles (Facts about Jordan Dam). Walter Bouldin Dam was constructed on a canal associated with Jordan Lake in 1967. Bouldin Dam has the greatest power generating capacity of any of the Coosa River dams (Walter Bouldin Dam). However, the dam facility suffered a breach in 1975 which resulted in a temporary shutdown of operations (at the time, Bouldin Dam was responsible for generating approximately 4% of Alabama Power Company electricity). Luckily, there were no human casualties associated with the failure (Atkins, 2006). Walter Bouldin Dam has a height of 120 feet. It is considered part of Jordan Lake so it is listed as having both the surface acres and watershed area of Jordan Lake (Facts about Walter Bouldin Dam).

Beginning in the 1950's there was a renewed interest in the building of dams on the remaining free-flowing portions of the Coosa River. Originally, the entire Coosa River was to be developed as a single program to induce maximum productivity. The Depression, the creation and competition of the federally-funded Tennessee Valley Authority (TVA), World War II, and an unfavorable political climate all contributed to the postponement of Coosa River dam construction (Atkins, 2006). In 1953, the Alabama Power Company filed an application to the Federal Power Commission (FPC) for permission to build five additional power plants on the Coosa (Atkins, 2006). This initiated the beginning of the new projects. More information regarding the renewal of dam-building on the Coosa River can be found in Chapter 4, "Results and Findings". Weiss Dam, now the northern boundary of H. Neely Henry Lake, was completed in 1961. Weiss Dam has a height of 126 feet which retains approximately 30,200 surface acres in the Weiss Lake impoundment. The area draining into Weiss Lake is about 5,273 square miles (Facts about Weiss Dam). Logan Martin Dam, near the town of Pell City, was completed in 1964 (Coosa Hydrologic Modifications). It has a height of 97 feet, 15,263 surface acres, and a watershed of approximately 7,700 square miles (Facts about Logan Martin Dam).

H. Neely Henry Dam was completed in 1966. The dam is 104 feet high and the watershed draining into the impoundment is about 6,600 square miles (Facts about H. Neely Henry Dam) (Appendix A includes a map showing Coosa River dam locations and their associated ages, also included are locations of dams associated with the Tallapoosa and Alabama Rivers). H. Neely Henry Lake covers approximately 78 miles from H. Neely Henry Dam upstream to Weiss Dam. Normal surface elevation (known as “full pool”) is 508 feet above sea level during the time period from May to October. From November to April, the lake elevation has traditionally been reduced to 505 feet above sea level. This drawdown exposes many shallow areas of the lake bottom which are submerged at full pool. In recent years, however, Alabama power has experimented with a lesser drawdown to only 507 feet above sea level (Alabama Power Company and Kleinschmidt Associates, 2000).

The lake includes 339 miles of shoreline with a maximum depth of 53 feet and an average depth of only 10.8 feet. The surface area of the lake is approximately 11,235 surface acres. In addition to hydroelectric power, the impoundment is used for flood control - the existence of Weiss and H. Neely Henry Dams regulate the volume of stream flow around the city of Gadsden and are effective means of flood reduction. More information on flooding events can be found in Chapter 2, “Impacts on Flood Frequency/Intensity”. In addition, H. Neely Henry Lake is utilized for drinking and industrial water supply, fish and wildlife habitat, and recreation (Alabama Power Company and Kleinschmidt Associates, 2000). More information on these uses can be found in Chapter 2, “Purpose of River Impoundment”. Appendix A includes the location of all Coosa River dams and a listing of their ages.

Summary of Introduction

The material presented in this chapter gives background information related to the history and formation of the Coosa River dams and the creation of H. Neely Henry Lake specifically. The information presented here is invaluable in understanding the background of the region and all of the interconnected factors which are related to the impoundment of the Coosa River.

CHAPTER 2

LITERATURE REVIEW

Purpose of River Impoundment

River impoundment can bring on drastic changes and can permanently alter the natural environment. Even though river impoundment can dramatically disrupt the natural landscape, it can provide numerous benefits to both human civilization and the associated natural environment as well. One of the popular reasons for river impoundment, especially in the case of the Coosa River, is that of hydroelectric power generation. Hydroelectric power is considered a renewable source of energy - a renewable source of energy is one that is not based on traditional fossil fuels such as coal, oil, or natural gas. Due to the contribution of fossil fuels to the global warming crisis and their dwindling reserves, renewable sources of energy such as hydroelectric power, wind and solar energy, biomass fuels and others should certainly be encouraged. In 2006, hydroelectric power was 4.13% of Alabama Power's generation output (Fact Card 2007). This may not seem very significant, but considering that 4.13% of Alabama Power's total power generation in 2004 was approximately 2,509,786,237 kilowatt-hours, it is certainly a significant power source for the state. In addition, 4.13% of Alabama Power's total sales in 2006 was worth about $173,772,609 (Fact Card 2007). Precipitation amounts may also affect the scope of hydroelectric power production so it is likely that the recent drought conditions in the southeast have lessened the amount of hydroelectric power that can be produced. The Tennessee Valley Authority (TVA) is a competing power producer located in the southeast United States in adjacent areas to those served by Alabama Power and its affiliates in its parent company, Southern Company. According to information received from TVA, they normally average between 7-10% hydroelectric power production. The drought conditions associated with 2007 caused a reduction to about 5% hydroelectric power production. In contrast, 2003 and 2004 saw TVA generate approximately 16% and 17% hydroelectric power, respectively.

Another aspect for the promotion of river impoundment is the act of flood control. River impoundments help control the water in a flowing river and function as a restricting force controlling water flow instead of allowing the river to travel freely downstream. H. Neely Henry Lake has very little flood preventative qualities because it has no deep water reservoir in its boundaries (Federal Emergency Management Agency, 1982). Weiss Lake, located immediately upstream, does include a deep-water reservoir which aids in the ability of the lake to deal with high flow conditions associated with minor and moderate flood events. Weiss dam and its associated reservoir, however, would not provide much protection from very high flow conditions associated with a large flood such as a 100-year event (Federal Emergency Management Agency, 1982). A 100-year flood event is one so large that it has a 1% chance of occurring in any one given year (an average of once every hundred years, as the name implies). This is a long term average, however, and certainly does not preclude a large flood event from occurring in short time intervals or even multiple times in one year.

Despite the lack of a deep-water reservoir, the level of H. Neely Henry Lake can be reduced in an effort to lessen the potential effects of flooding on the city of Gadsden and surrounding areas when there is a significant threat of a flood event. The level of drawdown is based on expected inflows from upstream (from Weiss Lake). When the total inflow at Gadsden – which includes waters originating from Weiss Lake plus all runoff accumulated between Weiss Dam and Gadsden – is expected to equal 28,500 cubic feet per second (cfs), H. Neely Henry Lake is drawn down one foot (Alabama

Power Company, 2002). If inflow is expected to increase to 33,000 cfs the lake is reduced two feet and flow estimated to top 37,000 cfs will result in a drawdown of three feet (Alabama Power Company, 2002). An expected discharge exceeding 40,000 cfs results in a drawdown of 5.5 feet. The level of H. Neely Henry Lake can be reduced at a rate up to approximately 4 inches per hour if necessary (Alabama Power Company, 2002). Specific information regarding flooding events can be found later in this chapter in the section, “Impacts on Flood Frequency/Intensity”.

The creation of recreation opportunities is another positive aspect of river impoundment. Recreation opportunities may indeed be the most well-known of the effects of river impoundment to the general public. Recreational activities associated with H. Neely Henry Lake include boating and other water sports, fishing, hunting, picnicking, walking, and scenic viewing. Numerous recreation sites have been constructed associated with the lake in order to accommodate these activities. This infrastructure includes boat marinas, launches, and slips, fishing and general piers, beaches, campgrounds, picnic areas and a host of other facilities (Alabama Power Company and Kleinschmidt Associates, 2000). A listing and description of these facilities can be found as Appendix B.

In 1998, the United States Army Corps of Engineers (ACOE) prepared a draft Environmental Impact Statement (EIS) for water allocation procedures regarding the Alabama-Coosa-Tallapoosa (ACT) Basin. The recreational usage (generated from 1995 data) included 170,431 total trips which translate to 501,268 total-visitor days. At that time, H. Neely Henry Lake was the fifth most popular lake in the ACT basin (U.S. Army Corps of Engineers, 1998) (Alabama Power Company and Kleinschmidt Associates, 2000). Tables 1 and 2 below give information regarding the recreational usage of the

Coosa River projects. Table 1 shows the amount of use during different times of the year for all Coosa River developments. It is not surprising the peak times of year for recreational use are during the spring and summer. Table 2 shows the popularity of different recreational activities for H. Neely Henry Lake specifically. These tables are included to provide a description of the different recreational opportunities available and aid in establishing recreation as a valid asset in the use of these impoundment projects.

Table 1: Recreational Use on Coosa River Lakes – 1995
Source: Alabama Power Company, 2002, United States Army Corps of Engineers, 1998

Table 1 Annual Usage, 1995 – *Coosa River Projects*

	Total Trips	Total Visitor-days	Winter (%)	Spring (%)	Summer (%)	Fall (%)
Weiss Lake	293,625	1,276,630	7	41	43	9
H. Neely Henry Lake	170,431	501,268	12	29	53	6
Logan Martin Lake	309,041	1,343,657	7	32	50	11
Lay Lake	149,977	453,185	17	43	31	9
Mitchell Lake	63,658	164,816	16	39	34	12
Jordan Lake	160,906	498,663	13	39	36	11

Source: Table 4-62, *Draft EIS: Water Allocation for the Alabama-Coosa-Tallapoosa (ACT) River Basin Main Report*, page 4-216.

Table 2: Specific Recreational Uses of H. Neely Henry Lake – 1995
Source: Alabama Power Company, 2002, United States Army Corps of Engineers, 1998

	Percentage (b)	1995 Visitor-days
H. Neely Henry Lake		
Fishing: shore	12	60,152
Fishing: boat	82	411,040
Pleasure boating	36	180,456
Water skiing	22	110,279
Jet skiing	7	35,089
Swimming	27	135,342
Camping	9	45,114
Picnicking	22	110,279
Hunting (c)	2	10,025

Fishing for largemouth bass (*Micropterus salmoides*) is one of the most popular forms of recreation on the lake. According to Alabama Power Company and Kleinschmidt Associates (2000), electro-fishing studies conducted by the Alabama Department of Conservation and Natural Resources (ADCNR) in the late 1980’s and early 1990’s indicate a healthy largemouth bass population with excellent growth rates exceeding the average statewide growth levels.

Information obtained from bass fishing tournaments can be used as well. The ADCNR created a program known as the Bass Anglers Information Team (BAIT). BAIT reports information to ADCNR such as bass average weight, number of bass per angler-day, and several other factors. Between 1986-1996, BAIT reports from H. Neely Henry Lake reported overall average success on the lake compared to other bodies of water in Alabama. This trend continued in 1999 with aspects such as success rate (percent of anglers with more than one bass at weigh-in), average weight, bass per angler-day and pounds per angler-day all being reported as average for that year (Alabama Power Company and Kleinschmidt Associates, 2000).

The creation of a reliable source of industrial and drinking water supply is another benefit of river impoundment. A stable source of water, such as that from an impoundment, is much preferred over a source which may fluctuate in quality and quantity on a seasonal basis such as a groundwater well or surface water from a free-flowing river. In addition, waters from an impounded reservoir experience a settling of suspended solids, increased dissolved oxygen, and contain lessened bacterial populations – all of which make impounded waters more desirable for municipal use (Baxter, 1977). The city of Gadsden receives its drinking water from a withdrawal system utilizing the surface waters of H. Neely Henry Lake. This withdrawal and subsequent treatment serves about 48,000 residents (Safe Drinking Water Information System). In addition, there are some other withdrawals which are associated with the industrial and agricultural sector. There are nine other water withdrawals systems associated with H. Neely Henry Lake or its tributaries (Alabama Power and Kleinschmidt Associates, 2000). According to available data, two of these systems are associated with “Gulf States Steel, Inc.” - a steel plant located in Gadsden which is no longer in operation. Judging by this, there does not appear to be a recent increase in industrial demand for water.

Hydrologic State of H. Neely Henry Lake

H. Neely Henry Lake is technically classified as a warm monomictic lake (Alabama Department of Environmental Management (ADEM) and Auburn University, 1997). A warm monomictic lake is one in which the water temperature is never less than 4 degrees Celsius. These lakes experience overturning (the seasonal mixing of lake waters) during the winter months while the lake waters are subject to a cooling effect due to lower air temperatures (Laws, 2000). The process of overturning varies from region to region and is largely dependent on climate (for instance, there are dimictic lakes which overturn twice in one year during the spring and fall seasons). During overturning, the lake temperature is generally homogeneous throughout the water column. Other times, the lake is thermally stratified, meaning there are distinct zones in the water column exhibiting different temperatures (Laws, 2000). H. Neely Henry Lake is somewhat of a special case, however. Due to its relatively shallow depth (an average of 3.3 meters) and short hydraulic retention time (approximately 5.8 days), the lake experiences weak thermal stratification even in its deeper portions (ADEM and Auburn University, 1997). According to the 1997 study, there is a marked absence of “classical thermoclines” (described as a change in temperature greater than or equal to 1 degree Celsius for every meter of depth). As a result, temperature gradients in the entire water column rarely exceeded 3 degrees Celsius during the study period (1993-1994). A deeper lake, for example, may experience temperature gradients exceeding 15 degrees Celsius (Thermal Stratification).

Human Impact of H. Neely Henry Lake

The effects of creating an impoundment can have far-reaching impacts on the people associated with the region. One of the foremost conflicts associated with the human population is the permanent acquisition (and subsequent flooding) of private lands associated with the new river impoundment. H. Neely Henry and other Coosa River impoundments envisioned during the 1950's were expected to inundate approximately 95,000 acres with water (Atkins, 2006). The following figures on pages 19, 20, and 21 give examples of the amount of land loss associated with the creation of H. Neely Henry Lake. The water depicted as blue is what existed pre-impoundment. The photorevisions of the maps in 1972 (post-impoundment) depict the newly-flooded areas as purple.

In some cases, attempting to purchase vast tracts of land presents little problem because the land in question is lightly inhabited and/or otherwise considered undesirable due to inhospitable topography, high flooding risk, close proximity to industrial or low income areas, or other factors. This was the case for similar Alabama Power impoundment projects on the Warrior River where a great portion of the land was rocky, steep, and sparsely settled giving many landowners little reason to refuse a generous offer from the Alabama Power Company to buy the land (Atkins, 2006).

There was a different situation entirely regarding the Coosa River impoundments. Many areas along the Coosa River are composed largely of fertile farmland which has been used for agriculture as long as the area has been settled (Atkins, 2006). There was a faction of farmers and other landowners who were adamantly opposed to the project. This group first petitioned the Federal Power Commission to deny a license to Alabama Power and then formed a landowner's association organized by Birmingham attorneys to oppose the Alabama Power Company development (Atkins, 2006).

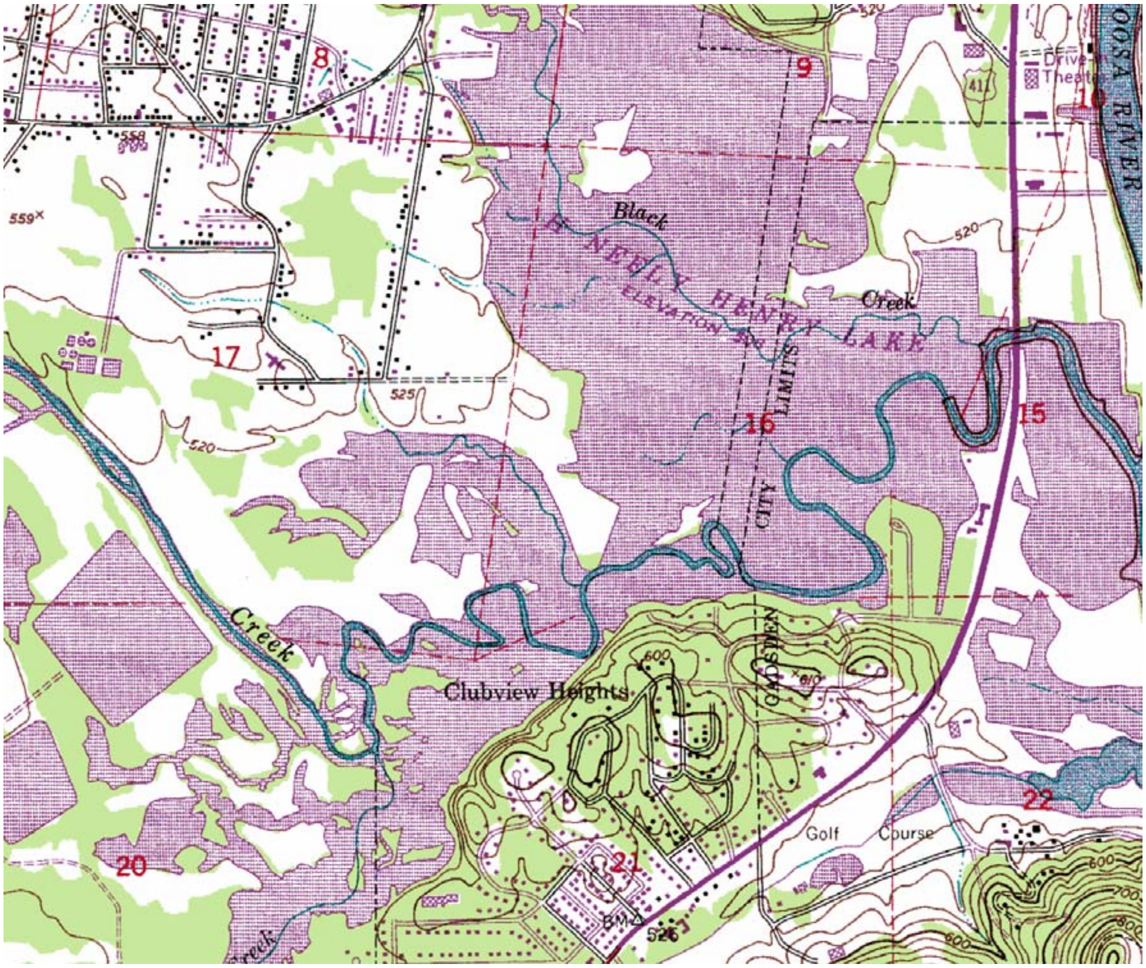

Figure 4: An example of land loss associated with river impoundment. The urban areas of the city of Gadsden lie immediately adjacent to the north and the main channel of the Coosa River is immediately adjacent to the east.
Source: USGS 7.5 Minute Topographic Quadrangle, “Dunaway Mountain, Alabama” 1947 (photorevised 1972)

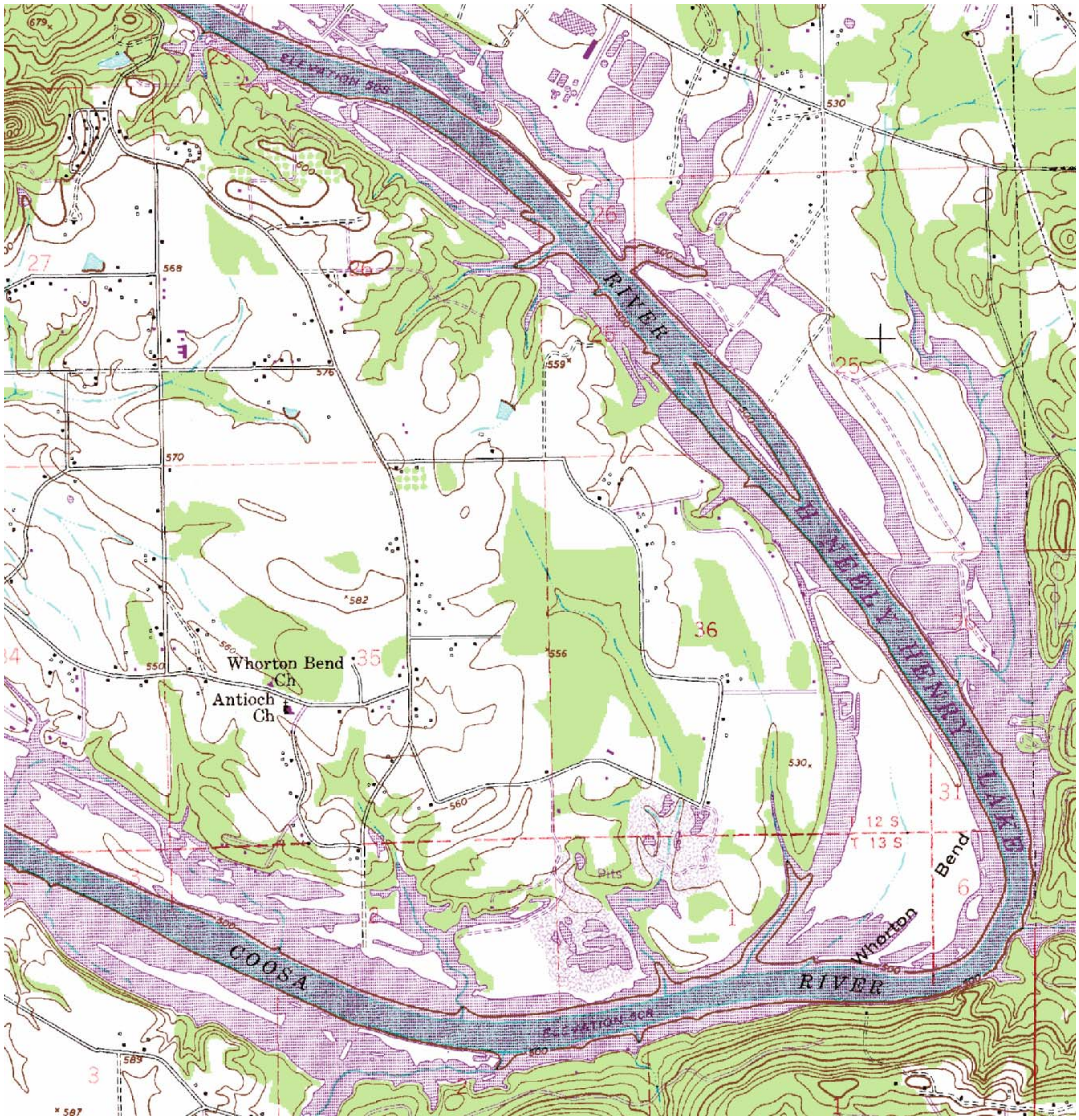

Figure 5: An example of land loss associated with river impoundment. This is the Whorton Bend area mentioned in the historical section of Chapter 1.
Source: USGS 7.5 Minute Topographic Quadrangle, "Glencoe, Alabama" 1956 (photorevised 1972)

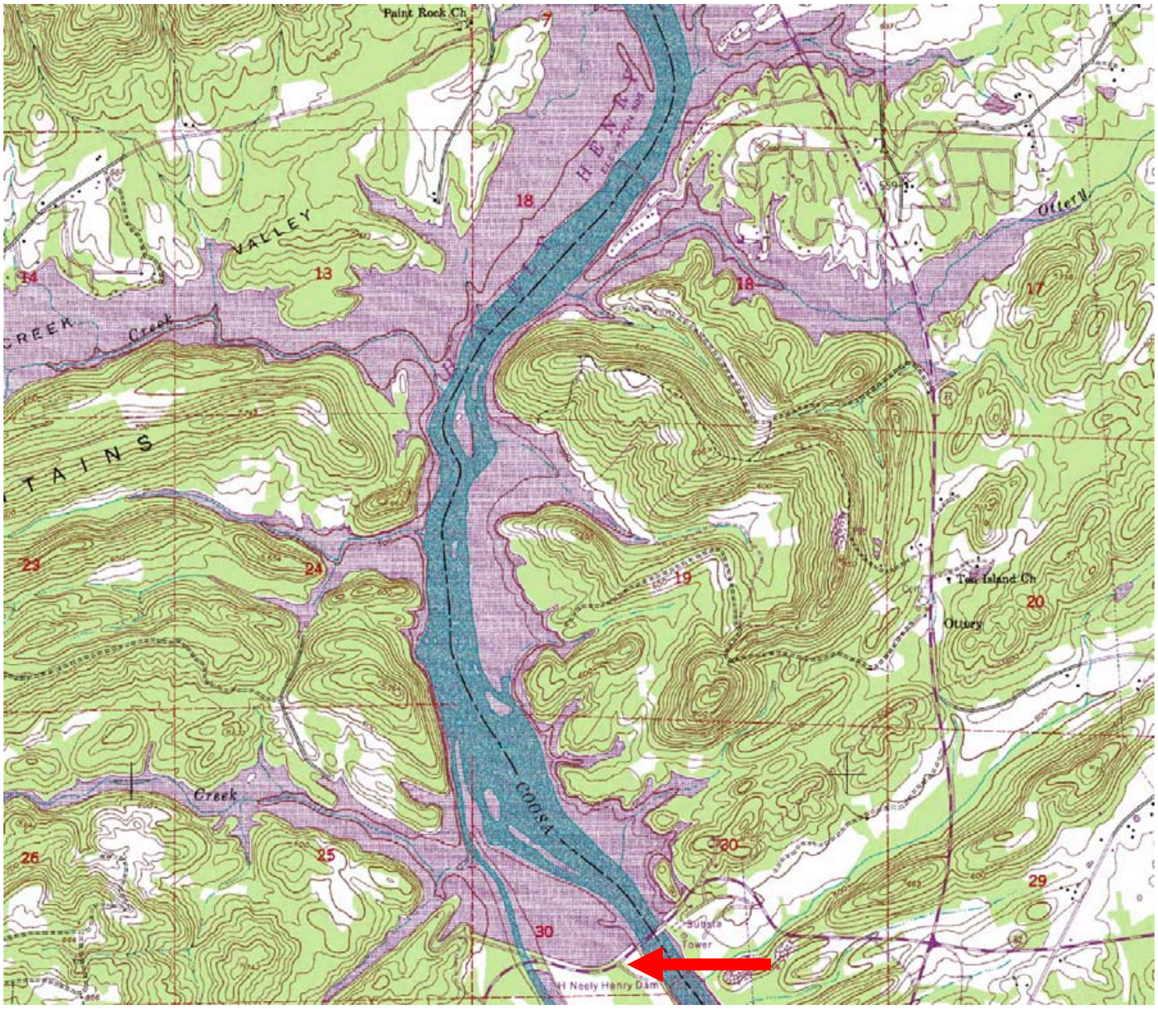

Figure 6: An example of land loss associated with river impoundment. This is the area immediately upstream of H. Neely Henry Dam. The red arrow indicates the dam location.
Source: USGS 7.5 Minute Topographic Quadrangle, “Ohatchee, Alabama” 1949 (photorevised 1972)

The Alabama Power Company made it a point to offer generous prices for the land and in so doing managed to outright purchase 95% of the land that was desired for the projects. The remaining cases were turned over to the courts for condemnation and eminent domain proceedings under authority given to Alabama Power by federal law. Federal law allowed an estimate of fair compensation for the land in question to be given to the court while construction activities began (Atkins, 2006). This action prevented compensation hearings which could have potentially delayed construction (Wascom, 2008).

In addition to the socio-cultural effects of residents losing their property, there were some archaeological concerns as well. As discussed earlier, there was significant settlement of the region by Native Americans before European settlement. The Alabama Power Company conducted cultural impact studies in areas where it was believed there would be significant detrimental effects to archaeological sites associated with Native American settlement (Tharpe, 2008). An Indian burial ground was found on Woods Island which is the present site of H. Neely Henry Dam (Figure 6). Those interned at this location were removed and reburied at a site unaffected by dam construction activities (Tharpe, 2008).

The economic status of the region both before and after the impoundment creation was also evaluated for this thesis. Impoundment creation is generally viewed as being very beneficial to the economy of the surrounding region. There are numerous positive impacts which can potentially result from the creation of an impoundment such as H. Neely Henry Lake. The increased recreational value of the area brings in additional funds from visitors as well as encourages the local population to utilize recreational facilities. Affordable and renewable power originating from a hydroelectric dam as well as a stable, clean water source from an impoundment offers benefits for the establishment of commercial and private entities. Property values of lakefront real estate are generally much higher than other areas making the landowners wealthier. Improved navigation may encourage shipping on the waterway. There is any number of factors or interactions of factors originating from the impoundment of a river which would boost a region’s economy.

Data from the United States Census Bureau was analyzed to measure any effects on the region's economy during a time period beginning before the creation of H. Neely Henry Lake to several years after it was completed. General parameters were selected which compared the Gadsden area to available data from other portions of the state in order to draw comparisons in growth rates. Table 3 shows comparisons of per capita income. Per capita income can be defined as the total income of the selected area divided by the population (Geaghan, 2008). The available data examined per capita income in the area for the years 1959, 1969, 1979, and 1989. Further analysis was conducted for the years 1959 and 1979 which were chosen to represent both a pre- and post-impoundment state. The United States is also included to provide a frame of reference regarding overall growth in the remainder of the country during this time frame.

Table 3: Per Capita Income by Metropolitan Statistical Area (1989 dollars)
Source: Compiled by author from U.S. Census Bureau,
www.census.gov/hhes/www/income/histinc/msa/msa3.html

Area	1959	1979	change	rank
United States	$7,259	$12,229	68.5%	7
Gadsden	$5,207	$10,230	96.5%	1
Birmingham	$6,463	$11,381	76.1%	4
Huntsville	$6,435	$11,814	83.6%	3
Mobile	$5,823	$10,108	73.6%	6
Montgomery	$6,106	$10,642	74.3%	5
Tuscaloosa	$4,929	$9,525	93.2%	2

The Gadsden area experiences a striking increase in per capita income in the years following the impoundment of the Coosa River, the greatest of any metropolitan area in the state with available data and 28% higher than the national average. Table 4 shows comparisons of median family income from the same areas and time frames. Median family income can be described as a division of the population into two equal parts – one half of families are below and one half of families are above the division (Geaghan, 2008).

Table 4: Median Family Income by Metropolitan Statistical Area (1989 dollars)
Source: Compiled by author from U.S. Census Bureau, www.census.gov/hhes/www/income/histinc/msa/msa2.html

Area	1959	1979	change	rank
United States	$22,210	$33,374	50.2%	7
Gadsden	$17,215	$27,272	58.4%	4
Birmingham	$20,024	$30,730	53.5%	5
Huntsville	$21,292	$34,424	61.7%	2
Mobile	$20,138	$28,937	43.7%	6
Montgomery	$18,745	$30,093	60.5%	3
Tuscaloosa	$16,771	$28,765	71.5%	1

According to this data from the Census Bureau, the Gadsden area experienced more modest growth during this time period with regard to median family income. In fact, Gadsden's growth (58.4%) was almost exactly the equivalent of the average of the six areas with available data (58.2%). Table 5 compares the same areas as previously with regard to change in population from the years 1960 to 1980. Population change in Alabama is included as a frame of reference. In addition, the data is portrayed on a county-by-county basis rather than metropolitan statistical area. It should be noted that the Gadsden Metropolitan Statistical Area (MSA) encompasses all of Etowah County and there is no difference in land area represented by the two. The MSA and county divisions were chosen because of their close geographical relationship with H. Neely Henry Lake. Any effects upon the economy or population generated by the H. Neely Henry development would be reflected in data associated with the Gadsden MSA and Etowah County.

Table 5: Population by County
Source: Compiled by author from U.S. Census Bureau,
www.census.gov/prod/cen1990/cph2/cph-2-1-1.pdf

Area	1960	1980	change	rank
Alabama	3,266,740	3,894,025	19.2%	3
Etowah (Gadsden)	96,980	103,057	6.3%	6
Jefferson (Birmingham)	634,864	671,371	5.8%	7
Madison (Huntsville)	117,348	196,966	67.8%	1
Mobile (Mobile)	314,301	364,980	16.1%	5
Montgomery (Montgomery)	169,210	197,038	16.4%	4
Tuscaloosa (Tuscaloosa)	109,047	137,541	26.1%	2

The Gadsden area experienced very little growth in population during this time period (6.3%), leading only the Birmingham area in growth rate and falling well below the average of the six areas (23.1%). Table 6 displays the differences in the same regions as it relates to the number of housing units.

Table 6: Housing Units by County
Source: Compiled by author from U.S. Census Bureau,
www.census.gov/prod/cen1990/cph2/cph-2-1-1.pdf

Area	1960	1980	change	rank
Alabama	967,466	1,467,427	51.7%	3
Etowah (Gadsden)	30,068	39,891	32.7%	7
Jefferson (Birmingham)	194,788	259,861	33.4%	6
Madison (Huntsville)	33,506	71,123	112.3%	1
Mobile (Mobile)	91,699	131,936	43.9%	5
Montgomery (Montgomery)	49,158	73,725	49.6%	4
Tuscaloosa (Tuscaloosa)	29,623	50,319	69.9%	2

The Gadsden area experienced little growth associated with housing units during the time period from 1960 to 1980 (32.7%), particularly with regard to other specific areas of the state (average of the six areas is 57%) and the state of Alabama in general (51.7%).

From this data, it is easy to conclude that the creation of H. Neely Henry Lake did not lead to a great influx of population. The increase in population and housing units over the time frame from 1960 to 1980 was very low, generally not even being remotely close to average for the state or other metropolitan areas. This fact makes it unlikely that there was a significant influx of new industry or other job opportunities related to the impoundment which would require additional work force. New industrial development can be a powerful driving force in a region's population, economy, and other factors. The Huntsville area is home to NASA's Marshall Space Flight Center (built in the early 1960's) which has served as a hub for NASA research and development. The creation of this large new industry is likely to be a contributing factor to the staggering increases in Huntsville (Madison County) population (67.8%) and housing units (112.3%) during the time frame analyzed.

Although the creation of H. Neely Henry Lake did not appear to foster a population or housing boom, there is evidence from Census Bureau data that the area did experience a period of relative prosperity for the twenty year period examined. Gadsden led the six metropolitan areas for increase in per capita income and experienced a modest gain in median family income. It should be noted that per capita income is not a highly reliable reference due to the fact that it can be easily skewed by a small number of anomalies (i.e. a small population of extremely wealthy residents could generate a falsely higher calculation) (Geaghan, 2008). It cannot be determined if the economic gains that were experienced can be attributed directly to effects from the impoundment of the Coosa River, but one could conclude that the creation of H. Neely Henry Lake had little, if any, negative effect with respect to income.

Environmental Impacts of H. Neely Henry Lake

There are a myriad of environmental impacts which result from the impoundment of a once free-flowing stream. Some of these are quite simple but provide a descriptive illustration of some of the changes brought about by impoundment creation. Jeffrey Stine (1991) provides an extremely accurate description of the basic environmental effects of dam building,

> "They transform flowing-water systems of rivers into still-water systems of impounded lakes, and in the process they eliminate rapids and shoals, create uniform river depths, slow the flow of the river, and increase siltation. Ecologically significant wetlands and bottomland hardwoods are destroyed through flooding, the dumping of dredged and excavated materials, the widening of river curves, and the construction of river bend cutoffs. Subsequent navigation on the river increases turbidity, waterborne pollutants, and bank erosion. Because the existence of large and varied fish and wildlife populations depend upon diversity in a river system, these populations are also harmed."

A reservoir formed by the damming of a free-flowing river is vastly different from a natural lake in the shape of its longitudinal profile (Baxter, 1977). While river reservoirs are usually deepest just above their confining dam, natural lakes are generally the deepest near their center. Baxter states that this may be due to the deflected currents at the dam which promote erosion of the bottom sediments in that area. Baxter adds that shoreline modification is likely to be greater in a reservoir created by impoundment due to periodic drawdowns which will subject additional areas to the various effects of shore processes. This is particularly true in H. Neely Henry Lake due to the extended seasonal lake drawdown which extends from November to April each year. The drawdown exposes shoreline to erosional forces resulting from wave action and currents. This shoreline is generally submerged during the growing season so it contains little or no vegetation to lessen the effects of erosion. Many landowners have constructed seawalls at the water's edge on their property to combat this problem. These seawalls are composed of a variety of materials including rip-rap, brick, wood, and concrete.

There are numerous well-documented positive environmental effects on water quality due to the impoundment of a river. One of these is a positive effect on surface water quality regarding its use in the industrial and domestic sectors. This is due to a settling of suspended solids. Suspended solids which are normally carried by stream flow will be deposited in bottom sediments once the flow enters a body of standing water such as a lake or impoundment (Baxter, 1977). In the quote above, Stine (1991) cites an increase in turbidity which is related to increased river navigation. This increase in turbidity would likely be localized and temporary and would not have much effect on the overall long-term water quality of the impoundment. As discussed earlier, recreational opportunities are enhanced, particularly regarding sport fishing. This can be largely due to the fact that the impoundment of a river creates an availability of benthic organisms which contribute to the food supply in the ecosystem - in addition to the increased food supply; an impounded river will also provide an abundance of cover for fish. This cover may consist of submerged trees and any number of other objects which have been inundated by the impoundment's creation (Baxter, 1977).

While an impoundment may be beneficial to one species, such as the largemouth bass in H. Neely Henry Lake, it has been noted that it can cause great harm to another. Baxter discusses several general principles regarding ecology which can provide some background information on why this may occur. One of the most striking observations made by Baxter associated with the biology of impoundments is the concept of Thienemann's Rules. August Thienemann (1882-1960) was a notable contributor to the fields of limnology and ecology (International Society of Limnology). He generated a set of guidelines regarding the health of a biological community which accurately depicts the effect of an impoundment on the ecosystem of a body of water. According to Baxter, Thienemann stated that the more diverse the conditions were in an ecosystem, the more species would be present in the biota associated with that ecosystem. This makes sense - more diverse conditions equal more opportunities to meet requirements that would satisfy acceptable living conditions for a range of organisms. A free-flowing stream contains greater diversity of conditions than an impounded reservoir. Thienemann also said that habitat disturbance (i.e. river impoundment) leads to a deviation from ideal conditions for much of the biota which causes a reduction or elimination of many species. The surviving species, however, experience an increase in development (Baxter, 1977) (International Society of Limnology). In the case of H. Neely Henry Lake, the largemouth bass is a good example of one of these “surviving species”. Black (2001) also supports the belief of reduced populations in fisheries associated with impoundments. He cites a study that found a 30-70% range of decreased catch from reservoirs which were previously free-flowing. Black also noted the presence of agricultural damage in these regions where the previously-occurring flood events were responsible for depositing nutrients and new soil on farmed lowlands. The impoundment of a river may have detrimental effects on terrestrial organisms as well. Williams (1997) reports that plant communities on the banks of rivers which have been dammed for hydroelectric power contain far fewer species than shoreline ecosystems associated with free-flowing streams. He cites a study which found that approximately one-third fewer species associated with large storage reservoirs as compared to natural sites. In addition, other impounded sites contained 15% fewer species.

Baxter also discusses the environmental effects of the impoundment on downstream areas. A good amount of sediment carried by a stream will be deposited in the reservoir. Many times, the downstream areas below a dam will be scoured by the stream picking up new sediment loads. This will cause erosion of the stream bed and shoreline below the dam. This is true for the case of H. Neely Henry Dam – the banks of the Coosa River immediately downstream of the dam are deeply eroded and scoured. The Alabama Power Company has placed rip-rap in these areas in an attempt to curb the erosion problem. The water flow from the dam can have other effects in downstream areas. Since H. Neely Henry Dam was constructed for the purposes of hydroelectric power, the amount of water discharged is extremely inconsistent and is generally dependent on the demand for electricity rather than rainfall amounts or other influencing factors. The widely varied flow released from below a hydroelectric dam can result in negative impacts on benthic organisms and overall diversity (Baxter, 1977). Outside of erosion control, there is no readily available information regarding efforts by the Alabama Power Company to mitigate the environmental effects of H. Neely Henry Dam on downstream areas.

An impoundment can also have a devastating effect upon migratory fish that depend on a certain length of free-flowing water for their existence. Anadromous fish are those that spend the majority of their lives in marine environments but migrate into freshwater areas to reproduce. According to Alabama Power and Kleinschmidt Associates (2000), there are three species of anadromous fish that have historically used portions of the Coosa River for spawning activities - these include: Alabama sturgeon (*Scaphirhynchus suttkusi*), Alabama shad (*Alosa alabamae*), and striped bass (*Morone saxatilis*). It is believed the construction of dams has greatly frustrated or blocked the efforts of these migratory fish in their spawning activities. The Alabama sturgeon is listed as a critically endangered species subject to the rule of the Endangered Species Act (Listing of the Alabama Sturgeon). Now considered one of the rarest fish in North America, its decline can be partly attributed to dam building (Alabama Sturgeon). The Alabama shad is considered a species of concern which indicates there is evidence of a low, unhealthy population but not sufficient proof or relevant research to warrant placement on the Endangered Species List (Alabama shad). Striped bass have a healthy population in H. Neely Henry and surrounding lakes. These striped bass originate from stocking efforts by the ADCNR and contribute greatly to the recreational fishing industry in the area. Catadromous fish are also migratory but spend the majority of their lives in freshwater and migrate to marine environments to reproduce. The American eel (*Anguilla rostrata*) is the only such species known to inhabit the Coosa River. Though documented on lower portions of the Coosa, their status is unknown in upper portions including the area associated with H. Neely Henry Lake due to the existence of downstream infrastructure including locks and dams (Alabama Power and Kleinschmidt Associates, 2000). There has been some concern regarding the status of American eel populations. The U.S. Fish and Wildlife Service researched the situation and issued a press release on January 30, 2007 declaring that the inclusion of the American eel into the Endangered Species Act was not warranted (U.S. Fish and Wildlife Service).

Francisco (2004) discussed the effectiveness of dams at retaining pollutants found in the water and the sediments. This may include nutrients such as nitrogen and phosphorus from agricultural fertilizer runoff in addition to heavy metals such as mercury or polychlorinated biphenyls (PCBs) from industrial discharges. It is implied that if these pollutants are present, it is generally believed it would be best if they are passed through the system as would occur in a free-flowing stream. Francisco notes that even though the retention of pollutants by an impoundment or other structure is harmful, the sudden release of these stored pollutants (which could occur through dam removal or other activities) can be much worse.

In the 1970's, the Edwards Dam on the Hudson River near Albany, New York was removed. The sediment stored by the dam was heavily contaminated with PCBs and greatly polluted some downstream areas. The pollution was so extensive that the state of New York was forced to close the river to fishing. Several years later, 180,000 cubic yards of contaminated sediment was removed from the river and an associated portion of the river was declared a federal Superfund site subject to rule of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Francisco, 2004). There is a possibility that H. Neely Henry Lake could face a similar situation, although there are no intentions at this point to remove H. Neely Henry Dam or any others on the Coosa River. Alabama Power and Kleinschmidt Associates (2000) state that there has been significant pollution of H. Neely Henry Lake and other portions of the Coosa River with PCBs from the General Electric Plant located upstream in Rome, Georgia (Rome and Gadsden are approximately 60 miles apart) - the pollution was significant enough that an advisory was issued in 1989 banning the eating of catfish from certain portions of the Coosa River below Rome which includes H. Neely Henry Lake. Catfish were banned due to the fact that their feeding habits make them the most susceptible to contamination from pollutants found in sediments. It is possible there could be a release similar in nature to the one occurring from the removal of the Edwards Dam on the Hudson River which could originate from dredging or other maintenance activities around the Coosa River dams. A map showing dam locations for the Coosa, Tallapoosa, and Alabama rivers is included as Appendix A. The map also shows the close proximity of several population centers to these impoundment systems.

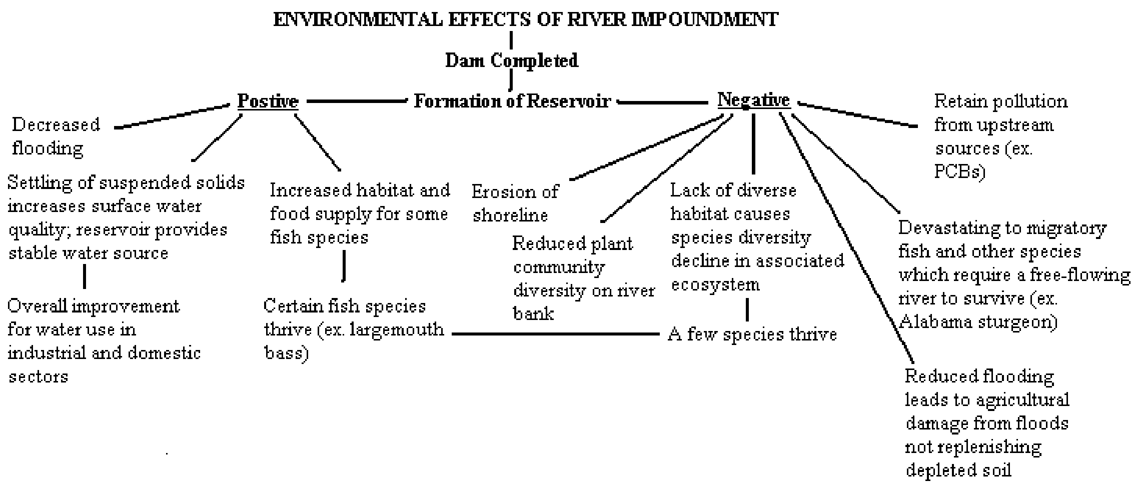

Figure 7: Environmental Effects of River Impoundment
Source: Compiled by Author

Impacts on Flood Frequency/Intensity

As stated before, one of the most popular reasons for dam creation is for the purpose of lessening or eliminating the effects of flooding, and the Coosa River dams are no exception. The United States Geological Survey (USGS) is the government agency charged with recording and researching the magnitude and frequency of flood events and as of September, 2003 maintained 169 water-level gaging stations in the state of Alabama alone (Hedgecock and Feaster, 2007). These gages are located on a variety of stream sizes from small tributaries to large rivers including the Coosa. Flood magnitude and frequency data from the gage located on the Coosa River at Gadsden (known as #02400500) was analyzed for this thesis. According to Hedgecock and Feaster (2007), there has been a gage at this location since 1891 and every year since the USGS has recorded the maximum stream flow for that year. With some exceptions, the data is recorded as both discharge in cubic feet per second (cfs) and the resulting gage height (in feet). Beginning in 1927, daily recordings are available so the exact date of the maximum stream flow is recorded as well. Prior to 1891, there is a recording of the 1886 flood which was determined to be a 500-year flood event (one so large it has only a 0.2% chance of occurring in any given year). The flood is well documented in historical sources and Neville (1966) gives an account of Coosa River steamboats traversing the streets of downtown Rome, Georgia during this catastrophic event. According to available data, there has not been a 500-year flood since that time. Data collected from this gaging station can be found as Appendix C.

As just mentioned and also discussed previously in the "Purpose of River Impoundment" section, the magnitude and frequency of flood events are characterized by a percentage of recurrence within a given year. These figures are generated from historical discharge rates. A 5-year flood event will occur on average once every five years which results in a 20% chance per year, a 50-year flood event will occur on average once every 50 years (or 2% chance per year), and so forth. It should be reinforced that these are long-term figures which do in no way mean that these floods cannot occur in shorter time intervals or even multiple times in one year. From USGS data compiled by Hedgecock and Feaster, here listed are the discharges associated with their specific recurrence intervals for Station Number 02400500, "Coosa River at Gadsden": 1.5-year event = 41,000 cfs, 2-year event = 47,400 cfs, 5-year event = 60,300 cfs, 10-year event = 68,800 cfs, 25-year event = 79,400 cfs, 50-year event = 87,400 cfs, 100-year event = 95,300 cfs, 200-year event = 103,000 cfs, and 500-year event = 114,000 cfs. For example, the 1886 flood mentioned earlier had an estimated discharge of 115,000 cfs and the highest recorded flow since that time occurred in 1916 which had a discharge of 85,000 cfs.

According to the Hedgecock and Feaster (2007), upstream of H. Neely Henry Lake the Coosa River flow is regulated by the dams at Carter's, Allatoona (both in Georgia), and Weiss impoundments. Data from Station 02400500 indicates a change in high-flow patterns in the early 1960's which appears to coincide with the construction of Weiss Dam (1961) which is the nearest one upstream from the gage location. Furthermore, prior to 1961, there are no regular trends detected; this indicates flow patterns consistent with a free-flowing stream (even though Allatoona Dam (1949) preceded Weiss Dam, its distance upstream prevented it from having more than a minimal impact on the area's flooding) (Hedgecock and Feaster, 2007). The authors state, "Flood flows after 1960 may be somewhat less in magnitude because of the effect of Weiss Reservoir upstream."

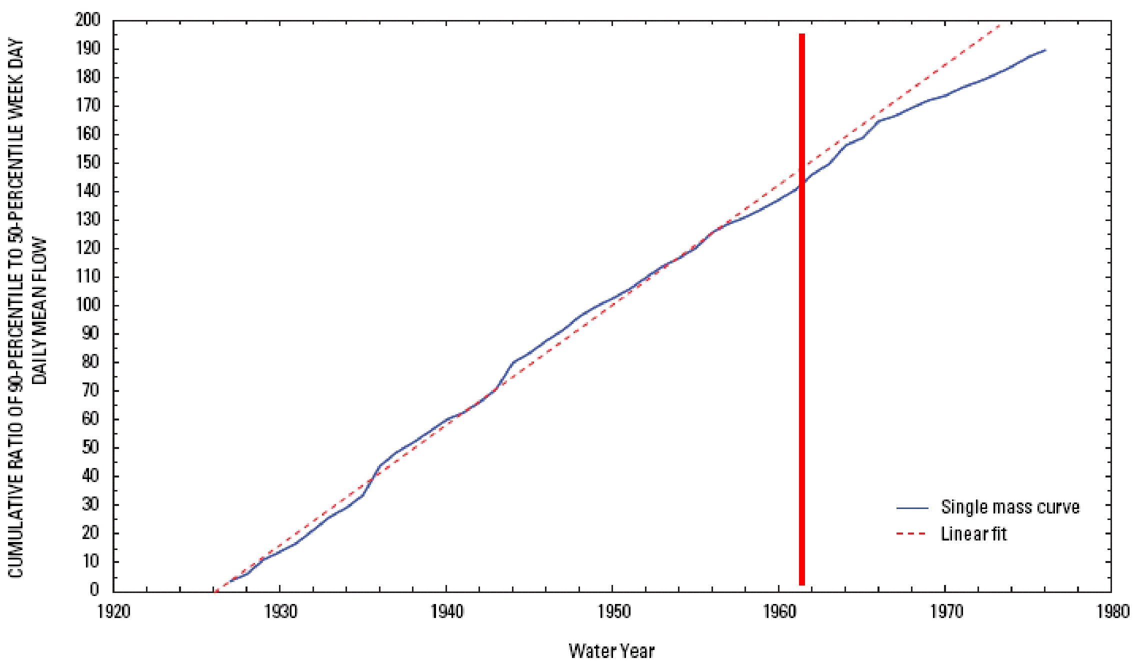

Figure 8: Single mass curve for the Coosa River at Gadsden (02400500), the red line marks the beginning of the impoundment period
Source: Hedgecock and Feaster, 2007, *Magnitude and Frequency of Flood Events in Alabama, 2003*

For analysis, the data from Station Number 02400500 was separated into pre-impoundment (1891-1960) and post-impoundment (1961-1996). The data from the 1886 flood was not used. During pre-impoundment, the average high flow event for a one year time frame was approximately 48,646 cfs. During post-impoundment, the average high flow event is approximately 44,797 cfs. This represents a 7.9% decrease. The median flood event for the two time periods decreased 3.2% from 47,800 cfs to 46,250 cfs. The table below displays the percentages of maximum flood events for each time period. Each year was categorized with its corresponding maximum flood size.

Table 7: Percentage of Flood Events for Each Time Period
Source: Compiled by author from Hedgecock and Feaster 2007, *Magnitude and Frequency of Floods in Alabama, 2003*

Flood Event	None	1.5	2	5	10	25	50	100	200	500
1891-1960	24.3%	24.3%	35.7%	5.7%	8.6%	1.4%	0%	0%	0%	0%
1961-1996	33.3%	25%	36.1%	2.8%	2.8%	0%	0%	0%	0%	0%

There is evidence to suggest that there is a reduction in flood frequency and magnitude during the time since the impoundment of the Coosa River. There is a 7.9% decrease in the average size of maximum flood events since 1961 and a 3.2% decrease in median size of maximum flood events. Looking at Table 7, it can be noted that there is a reduction particularly in the more severe flood events (5, 10, and 25 year floods) and an increase in years with no flood events at all (years with no recorded stream flow greater than or equal to 41,000 cfs). The stream flow regulation caused by a dam may have lessened the flood events as a whole causing what would have been 5, 10, or 25-year floods in an unregulated stream to decrease into 1.5 or 2-year floods. Similarly, potential smaller flood events were reduced to flows below 41,000 cfs eliminating them from being considered a flood event at all. It is difficult to say for certain from the data whether or not the Coosa River's dams were the sole cause of the flood reduction. There could be other issues which are a factor including varying rainfall amounts (i.e. an extended drought) or increased water use upstream – cities, industries, agriculture, and other entities upriver using more water.

Summary of Literature Review

Chapter 2 is a review of relevant research materials associated with analyzing the impacts of Coosa River impoundment and specifically H. Neely Henry Lake. Areas explored include purposes of river impoundment, hydrologic state, human impact, and environmental impact of H. Neely Henry Lake. In addition, the impoundment's effect on flood frequency/intensity is analyzed as well. This information is invaluable in evaluating the results and findings of this study which can be found in Chapter 4.

CHAPTER 3

RELATED RESEARCH

A Failed Impoundment Project: An Analysis of the Tennessee-Tombigee Waterway

The Coosa River belongs in the Mobile-Alabama River System (MARS) watershed. One of the other waterways sharing this basin is the Tennessee-Tombigbee (Tenn-Tom) Waterway (Appendix A and Figure 9 show the relation of the Coosa and the Tenn-Tom). The waterway was constructed as a connecting link between the Tennessee River and the Gulf of Mexico. Though mainly constructed for shipping, its course would take it through some of the most impoverished areas of the country – hopefully fostering economic development in these poor communities. The Tenn-Tom Waterway is 234 miles long from its northernmost portion at Pickwick Lake on the Tennessee River to where it connects with the Warrior-Tombigbee navigation system in Demopolis, Alabama (Construction). The waterway has ten locks (which overcome an elevation drop of 341 feet between Pickwick Lake and Demopolis) and dams, many miles of stream channelization, and a 29 mile excavated canal at its northern end which connects the Tennessee River's Pickwick Lake to the upper reaches of the old Tombigbee River watershed (Construction).

A project of this nature had been suggested on numerous occasions beginning as early as colonial times. The Tombigbee River was navigable for steamboat travel as far north as Amory, Mississippi which is about 150 miles upriver of Demopolis. Interested parties sought a link between there and the Tennessee River – this would in turn create a shipping route between the Tennessee River and Mobile Bay (History). The Federal Government officially studied the project in 1874 and 1913 but was relatively uninterested because of high cost and questionable benefits. Due to continuing studies by the United States Army Corps of Engineers (ACOE) combined with further development of the Tennessee River and Pickwick Lock and Dam, congressional approval was granted in 1946 (History). The construction of the Tenn-Tom Waterway survived a myriad of problems including lawsuits by environmental groups and railroad companies. Construction officially began in December, 1972 and was completed in December, 1984. The total cost was just shy of $2 billion (Construction). The building of the Tenn-Tom Waterway was the largest and most costly public works project ever performed by the ACOE at that time (Bierman and Rydzkowski, 1991). It was about $600 million more than the second costliest – the McClellan Kerr Waterway in Arkansas and Oklahoma (Patterson, 1986).

The Tenn-Tom Waterway can be divided into three distinct sections. The "Divide Cut", the northernmost portion, is a man-made canal connecting the watersheds of the Tennessee and Tombigbee Rivers. The middle part is known as the Canal Section. Stream channelization was used significantly in this portion to engineer the shallow, meandering upper reaches of the Tombigbee River into a navigable waterway. The southernmost section is the River Section. Most areas were naturally suitable for navigation but some portions did require channel dredging (Key Components).

The existence of the Tenn-Tom Waterway has been fraught with conflict since the beginning. A great deal of this conflict stems from the cost-benefit analysis of the project. Original cost estimates from the ACOE ranged from $323 million in 1970, $815 million in 1975, and then $1.36 billion in 1976 (Watkins). Estimates from parties other than the Corps estimated between $2-3 billion. As stated before, the actual cost upon completion was almost $2 billion. Economist Robert Haveman reviewed the project and generated a benefit cost ratio of only 0.3 – this means the building of the project would waste 70% of the money which was put into its construction (Watkins). The Tenn-Tom Waterway was constructed with the idea that it could serve as a shorter, alternate shipping route to the Gulf of Mexico rather than using the Mississippi River. One fundamental problem with the Tenn-Tom Waterway competing with the Mississippi is shipping size. The locks of the Tenn-Tom are built to accompany an eight barge tow, while the Mississippi River can support 30-40 barge tows (Bierman and Rydzkowski, 1991) (Watkins). Therefore, it takes many more shipments to move cargo on the Tenn-Tom, thus eliminating any money potentially saved by the shorter distance or time duration. Another significant problem encountered is the type of cargo which was supposed to be shipped on the waterway. Proponents of the Tenn-Tom counted very heavily on U.S. coal shipments being made on the new waterway (Bierman and Rydzkowski, 1991). However, coal being shipped downriver to Mobile would most likely be for export, which would go against the U.S. energy policy at the time which called for greater dependency on domestic coal (Phillips, 1982). According to ACOE projections, the new waterway would move approximately 18 million tons of coal south to Mobile for export during its first year. This would account for every ton of coal in the region (Bierman and Rydzkowski, 1991). Needless to say, this projection was met with opposition by local experts. Edward Passerini (1982), then professor of Humanities and the Environment at the University of Alabama, stated there would have to be a 300% to 500% increase in coal production in the region to meet the ACOE goals. Overall, the ACOE originally projected the waterway to transport about 28 million tons in its first year and eventually expand to 40 million tons per year – in actuality, the new waterway moved only 1.7 million tons in its first year and only 9.5 million tons in its first three years combined (1985-1987) (Bierman and Rydzkowski, 1991).

Another negative aspect associated with the construction of the Tenn-Tom Waterway is the potential effects on the environment. Environmental groups, such as the Environmental Defense Fund of New York, filed lawsuits to stop the project (History). One initial concern was the mixing of two unrelated river systems; ecologists feared it could be disastrous with such outcomes as hybridization of species and pollution of the Tombigbee by mercury from Pickwick Lake (Stine, 1991) (Stine, 1993). The project would turn the meandering, free-flowing Tombigbee River into a still-water barge canal and would almost certainly cause ecological harm to indigenous species which required a free-flowing river to survive. It was estimated that the building of the Tenn-Tom would destroy 50,000 acres of bottomland hardwoods (Stine (1993) stated that the loss of bottomland hardwood forests would be the greatest environmental tragedy of the waterway), cause the extinction or decline of numerous species of aquatic life such as fish and mussels, and erase about 9,000 acres of prime farmland (Phillips, 1982). One of the foremost environmental concerns of waterway construction was the disposal of millions of tons of excavated soil from areas such as the Divide Cut (Construction).

The Tenn-Tom Waterway was the first major water project built in compliance with the National Environmental Policy Act (NEPA) (Patterson, 1986) (Stine, 1991) (Stine, 1993). Many proponents of the waterway argued that the Tenn-Tom was environmentally safe because of this. NEPA, however, was in its infancy and several phases of construction had begun before the Environmental Impact Statements (EIS) were completed for the waterway (Stine, 1991) (Stine, 1993). Further details regarding the NEPA process can be found in Chapter 4, “Results and Findings”.

How was the project accomplished if it had so many negative aspects? The waterway gained congressional approval in 1946 but was not really initiated until

President Richard Nixon included it in his “Southern Strategy” which was Nixon’s attempt to sway the strongly Democratic south to the Republican Party (History). Nixon needed strong southern politicians on his side. The project was supported by Congressman Jamie Whitten and Senator John Stennis, both of Mississippi. Stennis was a powerful Senate member but more importantly he chaired the subcommittee which sets the ACOE budget and Jamie Whitten was a 23 term Congressman who was chairman of the powerful House Committee on Appropriations (Patterson, 1986). The ACOE may have felt pressured to encourage the waterway if it wanted funding for other projects. Why would Whitten, Stennis, and others support a project with such questionable benefits and a great potential to harm the environment? Watkins states that it was not really a question of cost-benefit but a question of the incidence of cost-benefit. He claims that the only people who genuinely stood to benefit were those directly associated with the construction of the waterway (constituents of Whitten and Stennis) but the cost of the waterway was directed to all American taxpayers. To add to this, it is known that Stennis owned about $65,000 in stock in two chemical companies which would benefit from the waterway construction, and fellow Mississippi Senator and waterway supporter James Eastland owned about $100,000 in stock in Mississippi Chemical Corporation, which also stood to benefit (Passerini, 1982).

The Tennessee-Tombigbee Waterway is an unfortunate example of an impoundment project that by many accounts has a very negative cost-benefit situation. The waterway seems to have been championed by those who stood to gain both politically and personally from its construction with little regard for the environmental, economic, and cultural consequences. This shows that not all large projects such as dam building and the impoundment of rivers are worth the time, effort, and resources needed for their completion. The purpose of this thesis is to determine whether or not the creation of H. Neely Henry impoundment was a worthwhile endeavor.

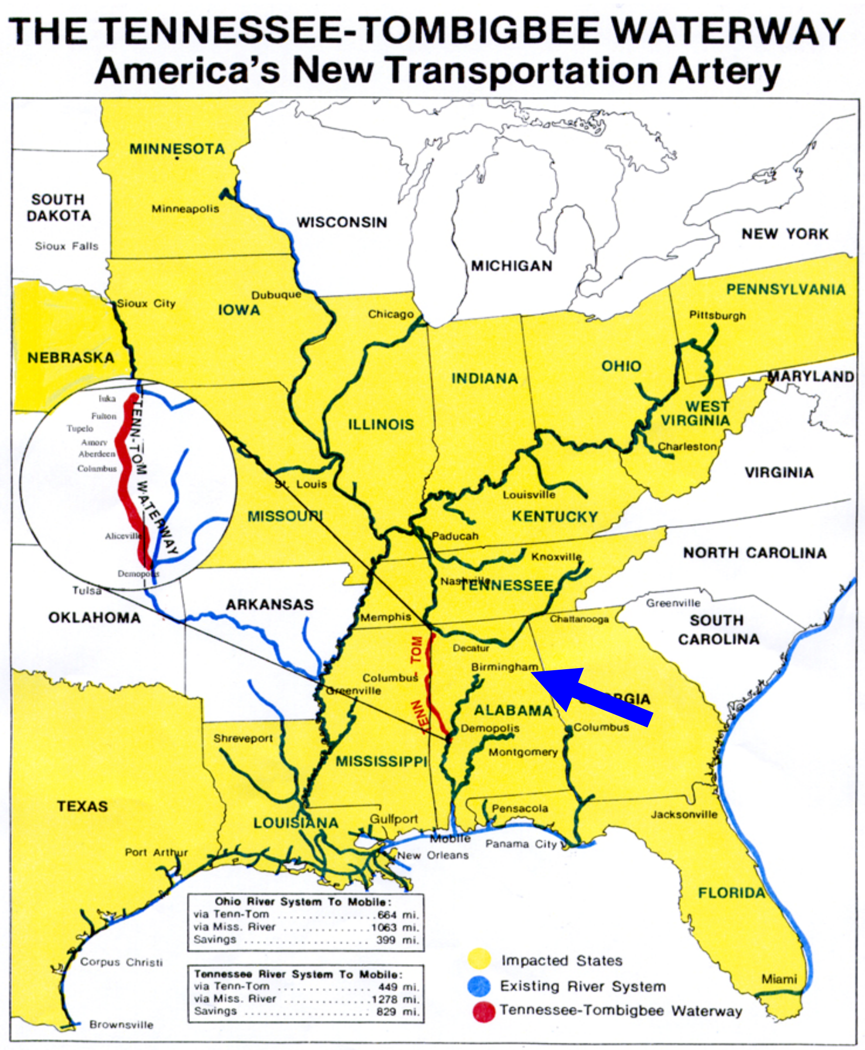

Figure 9: A View of the Tenn-Tom Waterway in Relation to Other River Systems, the blue arrow shows the location of H. Neely Henry Lake
Source: America's New Transportation Artery, Tennessee-Tombigbee Waterway Development Authority

Water Wars: Alabama, Georgia, and Florida Fight Over Shared Water Resources

For many years now, the Coosa River and its shareholders have been embroiled in a dispute regarding the use and allocation of the river's water. This conflict is directly related to the creation of Coosa River impoundments which have given man the ability to alter the amount of flow headed downstream. This situation is one unfortunate outcome of river impoundment.

Alabama, Georgia, and Florida have been locked in conflict in recent years regarding the shared resources of two river basins which lie in portions of all three states. These two river basins are the Alabama-Coosa-Tallapoosa (ACT) and the Apalachicola-Chattahoochee-Flint (ACF). Jordan and Wolf (2006) state, “The issues in the Water Wars are diverse and complex, involving surface and groundwater; as well as water quality, economic development, environmental interests, and the interbasin transfer of water.”

In the 1980’s water demand greatly increased in north Georgia mainly due to the expansion of the city of Atlanta. The United States Army Corps of Engineers (ACOE) agreed to evaluate reallocation of water storage in Lake Lanier, Lake Allatoona, and Carters Lake - the proposed reallocation would transfer water used for hydropower into water stored for drinking and other purposes (Jordan and Wolf, 2006). The reallocation would mean a lessened flow of water downstream. Lakes Allatoona and Carters directly provide a significant amount of water to the Coosa River as it flows southwest into Alabama from its origins in northern Georgia (Coosa Hydrologic Modifications). Alabama and Florida filed litigation challenging the ACOE documentation and procedures regarding the reallocation decisions (Florida is a stakeholder in the ACF basin which would be affected as well). One main procedural aspect cited in the Florida and Alabama litigation was the ACOE failure to use National Environmental Policy Act (NEPA) regulations in their evaluation of downstream effects of this flow reduction (Amicus Brief). Representatives from all three states agreed to meet and try to resolve the dispute without litigation. Sensing the impending regional conflict, Congress allocated funds in 1990 for the ACOE to begin a “comprehensive water-resources study” (Jordan and Wolf, 2006). This study evaluated the current status and uses of water resources as well as potential uses in the future. The comprehensive study was intended to provide a common baseline for all three states to express the concerns and needs over the water issue (Jordan and Wolf, 2006).

The process was successful in creating two interstate compacts (one for each basin). These compacts were adopted by all three states and ratified by Congress in 1997 - these compacts created frameworks, formed commissions, and established powers all in the name of addressing water allocation issues (Jordan and Wolf, 2006).

All issues were settled except for the all-important water allocation procedure. Given a deadline of December 31, 1998, extensions were granted into 2003 due to disagreement between the parties. Negotiations eventually failed which pushes the disagreement into federal court (Jordan and Wolf, 2006). As a stakeholder, I can attest to the fact that the failure of negotiations can largely be attributed to the mistrust among the concerned parties. Alabama stakeholders believe those in Georgia will take more water than necessary and severely deplete the flow coming into Alabama resulting in a myriad of problems including a depleted drinking water supply and environmental concerns. On the other hand, Georgia stakeholders are worried that parties in Alabama will take more water than is necessary potentially leaving the Atlanta area and other portions of northern Georgia without an adequate supply of drinking water. Jordan and Wolf (2006) discuss this precarious situation as well.

Summary of Related Research

This chapter includes research which is related to the Coosa River region and the overall impacts of river impoundment. These explanations are relevant for background information regarding these areas and aid in providing insight for the overall research purpose.

CHAPTER 4

RESULTS AND FINDINGS

The introductory materials presented provide a good base of reference for the research materials as a whole. Historically, rivers and other bodies of water have been a centerpiece of civilization because of their existence as a water source, food source, and potential mode of transportation. The Coosa River is no exception. The area associated with the modern H. Neely Henry Lake is well documented as being settled by thriving American-Indian communities before modern European settlement. These communities practiced agriculture in the fertile alluvial soils and utilized the river in many of the same ways we do today. The advancing technology of European settlers led to a thriving transportation industry on the river regarding the use of steamboats. It is no surprise that in recent times, we use modern technology to maintain the usefulness of the river for today's standards and form organizations such as the Alabama Power Company which can perform this duty for us. The creation of dams can be considered a manifestation of this desire to keep the river valid and useful for our intentions today. Impoundment creation encourages affordable and renewable hydroelectric power, cleaner drinking water, recreational opportunities, and reduced flood risk.

The region associated with H. Neely Henry Lake is located in a very unique geographical location. Located in the southern reaches of the Appalachian Mountains, the area lies in close proximity to three different physiographic regions. These include the "Valley and Ridge", "Cumberland Plateau", and "Piedmont Upland" physiographic provinces (Chapter 1, Figure 3). The unique geographic status of this area results in a stunning contrast of land forms. Lowland areas around the river are flat and contain fertile alluvial soils which are ideally suited for agriculture. In some places, these flat agricultural areas can be found only a few hundred yards away from a steep, rocky mountainside with a near-vertical ascent to elevations exceeding 1,000 feet above sea level.

There are numerous benefits which resulted from the impoundment of the upper Coosa River in the 1960's. One of the more popular is the advent of hydroelectric power generated from the Alabama Power Company dams. Hydroelectric power is renewable, which is certainly a plus in today's world of global warming, dwindling fossil fuel resources, and skyrocketing gasoline prices. For 2007, the nation's energy supply was composed of 7% renewable sources, 36% of that was hydroelectric power (Renewable and Alternative Fuels). This makes approximately 2.5% of the nation's energy based on hydroelectric power. In 2006, hydroelectric power was responsible for just over 4% of Alabama Power's energy sources, comparing that to 2004 total kilowatt-hours - this figure would have been responsible for about 2.5 billion kilowatt-hours of electricity (Fact Card 2007). The waters of H. Neely Henry Lake also provide a stable water source for the city of Gadsden's drinking water supply and numerous industrial uptakes as well. Baxter (1977) states that river impoundment encourages more favorable conditions for a drinking water supply such as decreased bacterial population, increased dissolved oxygen, and increased settling of suspended solids.

Enhanced recreational opportunities are also a result of river impoundment, and H. Neely Henry Lake is no exception. Dam building creates a body of water more similar to a still-water lake than a free-flowing river. Water levels are stabilized and magnitude of stream flow is generally reduced. The water level is raised (approximately 8 feet in the case of H. Neely Henry) which creates more water surface area. Property values are increased as the areas around the body of water are considered "lakefront".

Recreational infrastructure such as marinas, boat launches, piers, boathouses, campgrounds and others are generally initiated as well (Appendix A contains a listing of recreational infrastructure associated with H. Neely Henry Lake). H. Neely Henry Lake is a popular destination for recreational fishing, particularly for largemouth bass (*Micropterus salmoides*). The lake is host to numerous bass fishing tournaments held throughout the year which contribute to the local economy as a great many of the participants are not residents of the Gadsden area and spend money on lodging, food, and other essentials.

The largemouth bass is one fish species which has appeared to benefit from the impoundment of the Coosa River. It is believed that the increased cover and other habitat resulting from the rising water level increases the populations of benthic organisms which in turn provide more food for baitfish. Increased baitfish population leads to more food for larger species such as the largemouth bass. All of these organisms can then utilize the increased habitat and cover from the impoundment.

The increasing largemouth bass population along with the creation of H. Neely Henry Lake is not a good indicator, however, for the ecosystem as a whole. Largemouth bass may be a survivor species in the river as is explained by Thienemann’s Rules. Thienemann’s Rules state that the more diversity in an ecosystem, the more species will exist. Any habitat disturbance (like river impoundment) leads to a reduction or loss of species. Surviving species, however, have been known to thrive in the new conditions (Baxter, 1977). Black (2001) also cites evidence to support reduced fish populations in impounded streams. In addition, Williams (1997) reports a decrease in diversity of shoreline plants associated with a body of water once it has been impounded. He reports that shorelines of large reservoirs can contain up to one third less species diversity than a free-flowing stream in the same region.

Alabama Power and Kleinschmidt Associates (2000) report that the Coosa River dams have had a negative impact on migratory fish. The Coosa River once supported 3 species of anadromous fish (live in marine environments but migrate into freshwater to reproduce) and one species of catadromous fish (live in freshwater but migrate to marine environments to reproduce). The Coosa River dams have by all accounts effectively blocked the migrations of these fish.

It is reported by Alabama Power and Kleinschmidt Associates (2000) that H. Neely Henry Lake is significantly polluted with polychlorinated biphenyls (PCBs) originating from the General Electric Company in Rome, Georgia. Francisco (2004) discusses the implications of contaminated sediments being trapped behind dams and the implications of the pollution of downriver areas in case of a release. Francisco discusses dam removal as the culprit in one specific case in New York, which is unlikely in the case of H. Neely Henry or other Coosa River dams. It seems more likely to me a release could occur from Weiss or H. Neely Henry dams due to sediment disturbance from dam maintenance activities, dredging, or a very large flood event. Downstream areas can be greatly affected by dams, particularly regarding the inconsistent stream flow associated with hydroelectric dams.

No longer a free-flowing stream, H. Neely Henry Lake is now considered a warm monomictic lake (ADEM and Auburn University, 1997). A warm monomictic lake is one where the water temperature never goes below 4 degrees Celsius and experiences overturning during the winter (Laws, 2000). Due to short hydraulic retention time and relatively shallow depth, H. Neely Henry Lake lacks “classical” thermoclines (ADEM and Auburn University, 1997).

The extensive permanent flooding of land associated with the elevation of water levels can certainly be considered a negative aspect of river impoundment. Portions of land projected to be inundated by the construction of H. Neely Henry and Weiss dams contained very fertile farmland which, as mentioned earlier, had been used in agriculture for many generations stretching back to the time of Native American settlement. The Alabama Power Company made it a point to make generous offers to the landowners for the acquisition of the property desired and was successful in the outright purchase of approximately 95% of the land in question. The remaining disputed land was sent to the courts for eminent domain and condemnation proceedings (Atkins, 2006). Examples of land loss associated with H. Neely Henry Lake can be found in Chapter 2: Figures 4, 5, and 6.

What is really surprising regarding any environmental concerns associated with H. Neely Henry Lake is the lack of any pre-impoundment studies, environmental impact assessments or anything similar that may have been performed to assess potential environmental damage before the dam was constructed. The environmental movement was just gaining momentum and the creation of H. Neely Henry Lake immediately preceded such environmental statutes as the National Environmental Policy Act (NEPA) (1969), the Clean Air Act (1970) and the Clean Water Act (1972). Even with the increased environmental awareness of the late 1960’s, there is no readily accessible environmental impact study performed by the Alabama Power Company or any other organization prior to the creation of H. Neely Henry Lake.

The H. Neely Henry development and other later Coosa River dams were not free from government restriction. The 1945 Rivers and Harbors Act enacted by President Franklin D. Roosevelt proved to be a significant hurdle for the Alabama Power Company in its renewed efforts to impound the Coosa River. The act encouraged river development by promising $500 million to improve the nation's waterways, this included $60 million for further development of the Coosa River (Atkins, 2006). However, this act held a clause prohibiting the Federal Power Commission (FPC) from licensing any privately funded dams on the Coosa River (Atkins, 2006). This reserved development for federal entities such as the U.S. Army Corps of Engineers or TVA.

Conservative Dwight D. Eisenhower began his term as president in 1953. It is well documented he had a dislike of the practice of government power production and specifically TVA (Atkins, 2006). The more favorable political climate spurred action by the Alabama Power Company to try to overturn the restrictive clause in the 1945 Rivers and Harbors Act. The company presented Alabama Power's plan for Coosa development to the House Committee on Public Works in May, 1954. President Eisenhower signed the Coosa River development act in June, 1954 thereby granting the FPC permission to license Alabama Power to begin dam construction (Atkins, 2006).

In more modern times a project of the nature of the H. Neely Henry development would have to address aspects related to NEPA which is a set of guidelines established in 1970 to assess the environmental consequences of any major projects. NEPA guidelines are enacted when there is a proposed project that is considered "major federal action" (i.e. the Tenn-Tom Waterway discussed earlier). Even though the Coosa River dams are privately funded, there are numerous aspects of the project which could classify the dams as "major federal action". The first is the proposed impact upon a waterway which contains infrastructure constructed by the Federal Government for navigation purposes (Alabama Power and Kleinschmidt Associates, 2000) (Coosa Hydrologic Modifications) (Atkins, 2006). H. Neely Henry Dam itself is located at the site of "Lock 3" constructed in the late 1800's by federal efforts (Atkins, 2006). Further federal involvement could arise from issues related to the Clean Water Act concerning "waters of the United States" which are under jurisdiction of the U.S. Army Corps of Engineers. Section 404 of the Clean Water Act deals specifically with "waters of the United States" and is generally used to regulate the treatment of wetland areas. There is no doubt that the increased water level from dam building permanently inundated wetlands located in the floodplain of the old Coosa River which would be a serious concern related to Section 404 compliance - also for consideration is the significant effect regarding the degradation of water quality due to dam construction activities. Outside of the impoundment itself, any federal money used for road building, proposed recreation sites, or other infrastructure related to the H. Neely Henry development would be a consideration as well.

The NEPA process which was adopted in 1969 begins with a determination if the project in question will qualify for an Environmental Impact Statement (EIS) (Eccleston, 2001). An EIS will evaluate all aspects of potential environmental consequences and analyze those consequences with potential benefits to determine if the project has a favorable cost-benefit situation. Projects are classified in one of three ways: categorically excluded, disputed, or categorically included. A categorically excluded project might be immune from further NEPA review if it falls within a category of actions that have been pre-determined to not result in significant environmental impacts (Eccleston, 2001). A disputed project would require an Environmental Assessment (EA) to determine whether or not the action in question would require an EIS. An EA is basically just a shorter and more general overview of the impacts which would be examined by an EIS. Both of these reports include an analysis of the environmental impacts of the proposed project which include, but are not limited to, aspects of air quality, hazardous materials, water resources, floodplains, wetlands, endangered species, and archaeological/historical resources (Eccleston, 2001). There is analysis regarding the socioeconomic environment including impacts on land use, local economy, housing, recreational facilities, utilities, and other public services (Eccleston, 2001). There are also evaluations associated with the purpose of the proposed action, and analysis of possible alternative actions (Ecceleston, 2001). If it is determined that there will not be a significant impact, a Finding of No Significant Impact (FONSI) is issued allowing the proposed project to proceed. An EA which reveals potential significant impacts will result in an EIS. A categorically included project is one of such size and scope that there is no dispute that the project will require an EIS for approval. Therefore, there is no EA performed. It should be noted that for a disputed action there is no requirement to complete an EA and that an agency may forfeit the opportunity for a FONSI and perform an EIS if it chooses. Also, some agencies choose to complete an EA for large-scale categorically included projects in order to establish background information for the impending EIS (Eccleston, 2001).

There is little doubt that a project of the size and scope of the H. Neely Henry development and other Coosa River dams would require an EIS. It would be difficult to determine if the projects could pass the modern environmental scrutiny of the NEPA process in order to be completed. There are numerous negative aspects which would be explored in the EIS process. As discussed earlier, there were some serious consequences regarding archaeological/historical resources, particularly associated with Native

American settlements in the area. There is also the consideration of the effect on threatened and endangered species, specifically the migratory Alabama sturgeon which is now considered critically endangered and whose demise is partially blamed on dam building. It is likely some other issues analyzed regarding the aquatic environment would include reduction of species diversity, wetland elimination, and the retention of pollutants from upstream.

In contrast, the EIS would also evaluate the positive aspects of the potential impoundment. Two of the most important positive facets would be the promotion of renewable hydroelectric power and the flood control opportunities created by the dams. In addition, the enhanced recreational benefit of the river would be explored as well as its potential positive effects on the area's economy.

Additionally, the EIS would evaluate alternatives to the proposed action. If the EIS were conducted for the entire upper river, these would include alternative river projects – maybe an alternative project including fewer larger dams or a project which called for more dams which were smaller in stature. The no-action alternative would also be explored (leaving the Coosa River in its natural state).

The effect of the impoundment on the region's economy and population was also analyzed for this thesis. There was a dramatic increase in per capita income and a modest increase in median family income from pre-impoundment to post-impoundment. Per capita income, however, can sometimes be an unreliable economic indicator. There was little increase in population and housing units in the area over the same time period showing there was not a great influx of population which could have potentially occurred to satisfy the job demand for new industries drawn to the area. The creation of H. Neely

Henry Lake does not appear to have created an economic boom for the region but it also does not appear it was detrimental to the area either.

The effectiveness of the Coosa River impoundments on flood control was studied as well. Historical stream flow rates from USGS gage #02400500 ("Coosa River at Gadsden") were analyzed to determine both pre- and post-impoundment flood magnitude and frequency. Every year since 1891, gage #02400500 has recorded the maximum flood event for that particular year (Hedgecock and Feaster, 2007). This gage is located between Weiss Dam (1961) to the north and H. Neely Henry Dam (1966) to the south so this location began experiencing the effects of flood control with the completion of Weiss Dam in 1961. Between 1961 and 1996, the gage experienced a 7.9% decrease in average maximum flood size and a 3.2% decrease in median size of yearly maximum flood. Overall, there were fewer 5, 10, and 25-year flood events than during the pre-impoundment period and an increase in years with no flood events at all (Chapter 2, Table 7). There has been a decrease in the magnitude and frequency of flood events in the Gadsden area since the construction of Weiss Dam. There could be other contributing factors, however, such as extended periods of drought or increased uptake of surface water upstream for use in municipal, commercial, or industrial sectors.

Overall, river impoundment is generally viewed as being a benefit to society well worth the time, money, and materials used in the extensive construction process. There are some instances, however, where there are gross miscalculations of cost/benefit analysis, political pressure, and a number of other factors which promote the creation of a project that should never have existed beyond the initial planning stages. Though the Coosa River impoundments are generally viewed as a success, the Tennessee-Tombigbee Waterway (Tenn-Tom) located in Mississippi and Alabama is an example of a project that many view as a failure. The Tenn-Tom offers a shortcut to the Gulf of Mexico for shipping vessels using the Tennessee and Ohio Rivers, the idea being the shippers use the Tenn-Tom in lieu of the Mississippi River. Despite outrageously negative cost/benefit analyses from neutral parties, the project was initiated from what appears to be political motivation. Republican President Richard Nixon wanted to try to gain favor in the strongly Democratic South so he approved the project which was being championed by powerful southern politicians such as Mississippi Congressman Jamie Whitten and Mississippi Senator John Stennis. Constructed and maintained by the US Army Corps of Engineers, so far the Tenn-Tom has proven to be a monumental waste of funds, materials, and the natural environment that all of its opponents had predicted.

The Tenn-Tom Waterway was the first major water project built in compliance with NEPA (Patterson, 1986) (Stine, 1991) (Stine, 1993). Although some would argue that the then brand new NEPA legislation was not completely adhered to and a great deal of planning, financing, construction, and other waterway activities were begun before an acceptable EIS was completed for the project (Stine, 1991) (Stine, 1993). The Tenn-Tom Waterway is a tremendously different project than the H. Neely Henry development or other Coosa River projects. The NEPA process addressed several unique issues regarding the Tenn-Tom which are not present in the Coosa River projects. One main difference is the vast magnitude of the project. The Tenn-Tom required a 29-mile canal excavation (known as the “Divide Cut”) to link the Tennessee and Tombigbee River watersheds. In addition, many more miles of the waterway required stream channelization and channel dredging to create a waterway navigable to barge traffic. In total, the Tenn-Tom construction activities required more excavation than the Panama Canal (Stine, 1991). The dams on the Tenn-Tom all have locks which facilitate the movement of barge traffic through the waterway and these dams are not used for hydroelectric power as is the case on the Coosa River. These fundamental differences spawned a host of environmental concerns which were not a factor in the Coosa River dams. The disposal of the many tons (an estimated 300 million cubic yards) of excavated material from the Divide Cut and other areas which were subject to dredging and stream channelization was one of the greatest environmental concerns (Stine, 1991) (Construction). Also unique to the Tenn-Tom is the mixing of two distinct river systems. The effect of this type of action was very poorly understood and was feared to have potentially disastrous effects on the ecology of the river - interbreeding and hybridization of species was one fear (Stine, 1991) (Stine, 1993).

There are however, a significant amount of similarities in environmental impacts researched for the construction of the Tenn-Tom and impacts associated with the H. Neely Henry development and other Coosa River dams. One of the first and most obvious is the land loss associated with dam construction and the elevation of water levels. The Tenn-Tom Waterway flooded approximately 40,000 acres but includes approximately 60,000 more acres used for disposal of excavated materials and other uses (Stine, 1991). The upper Coosa River projects (Weiss, H. Neely Henry, and Logan Martin) are estimated to have inundated about 95,000 acres with water (Atkins, 2006). There are also similarities regarding threats to archaeological sites associated with historic Native American settlement. There was similar Native American artifact removal efforts conducted in the area of the Divide Cut of the Tenn-Tom as occurred on Woods Island regarding the construction of H. Neely Henry Dam (Binkley, 1978). The damming of a previously free-flowing river and the subsequent loss of vital habitat was a concern in both projects. Before the construction of the Tenn-Tom, the Tombigbee River was the last significant free-flowing river in the entire Mobile Basin drainage area and free-flowing rivers were becoming more rare in the entire nation as a whole (Stine, 1991). The old Tombigbee River held an abundance of shallow gravel bars which were an important habitat for mollusks (specifically the rare naiad mussel) – most of these areas would be destroyed with the construction of the Tenn-Tom (Stine, 1991). Regarding the Coosa River, the decline of the migratory Alabama sturgeon can be partially attributed to dam building and other impoundment activities. Similar construction activities occurred at the two projects which generated similar temporary effects upon water quality such as increased turbidity and erosion. Stine (1991) also makes note of the impoundments of the Tenn-Tom trapping sediments normally carried downriver and eventually deposited in Mobile Bay – the loss of the nutrients and silt in these sediments would have unknown effects upon the ecosystem of the bay. This concern can be correlated to the Coosa River projects as the waters of the Coosa eventually flow into Mobile Bay (see Appendix A) as well and one can assume contributed nutrients and silt to the bay's waters at a much higher rate before impoundment of the river. Pollutants in the river's sediments will be retained as well (Francisco, 2004). This could be a concern on the upper portion of the Tenn-Tom where it was feared heavy metals (specifically mercury) from Pickwick Lake on the Tennessee River would contaminate the waters of the Tenn-Tom (Stine, 1991) (Stine, 1993). A similar situation exists on the Coosa River; there is significant contamination of the upper portions of the river from PCB's originating from the General Electric facility in Rome, Georgia (Alabama Power and Kleinschmidt Associates, 2000).

It is an unfortunate fact that natural resources do not respect the creation of political boundaries. This situation has been the source of many disputes the world over regarding the use of natural resources, particularly that of water. Recently, the Coosa

River has been embroiled in such a debate with regard to interstate water resources. As stated previously, the Coosa River has its origins in northern Georgia before winding its way into Alabama. With the wild expansion of the city of Atlanta, it was proposed that portions of the headwaters of the Coosa River be retained for municipal use by the city of Atlanta. This proposal would have led to a reduced flow reaching the state of Alabama with potentially negative consequences. Needless to say, parties in Alabama were not pleased with this prospect and took legal action in an attempt to prevent its occurrence. There has been a comprehensive water management plan created in an attempt to resolve the situation but there has not been an agreement reached on the allocation of water. This particular argument has been ongoing since 1998 and has now been left up to litigation to decide - this was the course of action that the parties were attempting to avoid in the first place. There are no easy solutions in this matter as there is a general distrust among the interested parties about the intentions of the other party to potentially take more water than is necessary leaving the remaining population at a loss.

A comprehensive management plan, such as the one created regarding the dispute over the waters of the Coosa River, is certainly a step in the right direction in conflict resolution. A comprehensive plan would address all relevant aspects for a region's population and resources and generate equitable, well-planned solutions to any existing or threatening issues. Unfortunately, the Coosa River basin does not employ a comprehensive management plan. This can sometimes create an environment where conflicting interests in the region are at odds over how resources are used and shared. Often, this can lead to misappropriation and other unfair uses of the resources simply because one of the conflicting parties was more politically or financially inclined than the other.

Summary of Findings

This chapter gives an overview of the results of the research conducted on the effects of river impoundment and H. Neely Henry Lake specifically. The background of the region is discussed including relevant area geography and significant historical facts. Also discussed are the cultural, environmental, recreational, and flood prevention aspects of H. Neely Henry Lake as well as related research regarding the Tennessee-Tombigbee Waterway and the fight for Coosa River water rights between Alabama and Georgia. The final chapter will include conclusions and recommendations generated from the research.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Overall, the Coosa River impoundments and H. Neely Henry Lake specifically have been beneficial to the region. Increased recreational opportunities, affordable and renewable power, and reduced flood risk are all positive outcomes from the impoundment of the Coosa River. From personal experience, real estate around the lake increases in price every year, and lakefront real estate prices have been at a premium especially since the early 1990's. As a resident of the area, it is difficult to imagine what it would be like if the Coosa River was still a free-flowing stream as it existed historically. There are negative aspects to go along with the positive ones, however, and the purpose of this research is to provide a useful framework for other researchers to establish impacts for similar projects.

One fundamental flaw encountered in the creation of H. Neely Henry Lake is the lack of a pre-impoundment environmental impact study which weighs the potential effects of the impoundment's creation on the natural environment associated with it. As stated earlier, the creation of the Coosa River impoundments predated significant federal environmental statutes of the early 1970's by several years. Even so, there was an increased environmental awareness in the late 1960's which makes it surprising that the Alabama Power Company did not include some form of pre-impoundment environmental study in their standard operating procedure. This type of study is a given in today's environmentally-conscious atmosphere. As discussed previously, H. Neely Henry Lake and other Coosa River impoundments might have been altered or not allowed to proceed at all if the environmental effects had been examined under the scrutiny of NEPA, the Clean Water Act and other present environmental statutes.

In addition to possible negative effects on the environment, impoundment creation can also affect cultural resources. A cultural/archaeological resources survey should be conducted in the region in question to determine what resources may be affected by construction activities and/or rising water level. The Alabama Power Company did perform cultural impact studies regarding the existence of Native American archaeological sites which were found during construction. There is a provision in the Code of Alabama (Sections 41-3-1 through 41-3-6, enacted 1915) which allows for authorized agents of the state to remove such artifacts with permission of the landowner (Indian Burial and Sacred Grounds Watch). NEPA now requires such a cultural/archaeological survey and removal be conducted if relevant. An Indian burial ground was found on Woods Island at the current site of H. Neely Henry Dam and was removed to another location unaffected by dam construction activities (Tharpe, 2008). The presence of these cultural/archaeological resources could have affected the status of H. Neely Henry Dam and other Coosa River projects under the rule of modern environmental statutes. The removal of residents from their homesteads and property is also a cultural concern. The Alabama Power Company made it a point to offer generous prices for the purchase of land in an attempt to adequately compensate landowners for their losses resulting in 95% of the land needed being purchased outright (Atkins, 2006). The Alabama Power Company employees involved in the purchase of these lands realized that it would be bad for public relations with their future fellow land owners and customers if fair prices were not offered for the acquisition of the needed land. One employee was remembered as saying that "…the company is not well served by driving too hard a bargain" (Atkins, 2006). These two factors have become major concerns in the construction of China's massive Three Gorges Dam on the Yangtze River. The reservoir created by the Three Gorges Dam is expected to inundate numerous valuable archaeological sites, some of which have yet to be discovered. In addition, as of October, 2007, the impoundment has displaced approximately 1.4 million people with total estimates of displaced population reaching as high as 2.3 million. There are already reports of government corruption denying residents compensation for their lost property and homes (Three Gorges Dam).

The Alabama Power Company is a private corporation and this appears to be a positive selling point when conducting a large-scale project such as the construction of a dam. A private company generally utilizes private funding for projects which forces any decision-making steps to be very well analyzed as the private company in question most likely does not want to waste its own money. It seems that federal entities with access to taxpayer’s dollars are much more cavalier in their attitudes regarding the funding of a questionable large-scale project. The Tennessee-Tombigbee Waterway constructed by the federally-funded US Army Corps of Engineers is a good example of this. Another example is the federally-funded Tennessee Valley Authority’s (TVA) construction of several nuclear power plants along the Tennessee River in north Alabama. Construction was completed on these plants at a great cost to taxpayers but some of the plants never began operations due to questionable cost/benefit situations regarding the use of nuclear power. One in particular, Bellefonte Nuclear Plant near Scottsboro, Alabama, has been virtually abandoned leaving the giant cooling towers and other infrastructure as a reminder of wasted time, funding, and manpower. There certainly needs to be some form of oversight associated with these projects in their beginning stages which if implemented may encourage closer analysis of cost-benefit situations. The Congressional Committee on Oversight and Government Reform may need to become involved earlier in the evaluation of major federal action. This committee considers the environment one of its key issues and in the month of August, 2008 initiated several actions concerning the environment. These included issuing a subpoena for Clean Water Act (CWA) documents from the EPA to evaluate the agency's faltering enforcement and questioning the U.S. Army Corps of Engineers regarding the CWA and its relation to the Los Angeles and Santa Cruz Rivers in California (Latest News).

For major federal action such as the TVA nuclear power plants or the Tenn-Tom Waterway, the Committee on Oversight and Government Reform should be involved from very early on in the process. It would be wise for the committee to retain their own economists, scientists, and other researchers to give a separate opinion of the action being suggested. This process would be beneficial in the establishment of quality assurance.

On a regional scale, it would be very beneficial for stakeholders in the Coosa River basin to research and develop a comprehensive management plan for the region. This would be similar to the currently suspended efforts associated with the water allocation issues discussed in Chapter 3. This comprehensive plan, however, would address many other issues besides water allocation. It would provide guidelines for the management of environmental, economic, and socio-cultural conflicts arising in matters associated with the Coosa River. It would provide a valuable reference point for the management of the Coosa River and its resources.

The comprehensive plan for the Coosa River basin should be multi-faceted. To begin with, it could be based on some basic guiding principles which would outline the goals of the plan. These could include preservation of cultural/historical sites, promotion of smart land-use strategies, equitable distribution and use of water resources, or any number of other issues. Objectives for these guidelines could then be established. For example, any Native American archaeological sites near developing areas should be excavated, removed, and preserved by qualified professionals. Smart land use strategies could be encouraged by requiring a switch to no-till agriculture which is better for the environment through runoff reduction and other measures. Targets for these objectives must be set such as pursuing a no-net loss of wetlands in the basin regarding the use of water resources or a certain reduction in suspended solids in the Coosa River due to better land-use practices. The plan would outline the strategies and tools to achieve these effects. Some potential strategies could be arranging for government subsidies to be distributed to farmers using no-till agriculture or tax breaks for households and businesses which conserve their usage of water (Comprehensive Plan – Basin Plan Relationship).

Summary

A river impoundment is a serious undertaking involving many factors which can contribute both positively and negatively to the final outcome of the project. All factors discussed in this research must be scrutinized down to the last detail when evaluating if the act of impounding a river would be overall worth the effort and if in the end the benefits outweigh the costs. H. Neely Henry Lake has proven to be beneficial to the region, but as discussed before, all impoundment projects are not equal and some have definitely not met the expectations set for them.

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APPENDIX A: COOSA, TALLAPOOSA, AND ALABAMA RIVER DAMS

Source: Interactive Waterway Map, Coosa-Alabama River Improvement Association, http://www.caria.org/waterway_facts.html

Coosa River Dams
Lay Dam – 1914
Mitchell Dam – 1923
Jordan Dam – 1928
Weiss Dam – 1961
Logan Martin Dam – 1964
H. Neely Henry Dam – 1966
Walter Bouldin Dam – 1967

APPENDIX B: RECREATIONAL FACILITIES ON H. NEELY HENRY LAKE

Facilities	Parking	Boat Launch	Boat Slips	Boat Rental	Boat Repair	Boat Sales and Servic	Boat Storage	Fuel Services	Dock Pumps	Tackle & Bait	Fishing Pier	General Pier	Fishing Guide Services	Marine Sports Supplies	Groceries/Food Serv.	Camping Areas	Rental Cabins/Rooms	RV or Trailer Park	Dump Station	Swimming Pool	Swimming Area	Picnic Area	Outdoor grills/BBQ	Playground	Trail	Restrooms	Bathhouse	Other
Alford Bend Boat Ramp	✓	✓																										
Buck's Boat	✓	✓	✓		✓		✓	✓				✓		✓	✓											✓		
Canoe Creek Boat Launch and Groceries	✓	✓								✓		✓			✓													
Canoe Creek Fish Camp	✓	✓								✓		✓														✓		
Canoe Creek Marina	✓	✓	✓									✓														✓		
City of Gadsden Park	✓	✓		✓				✓		✓		✓		✓	✓											✓		
Coats Bend Road Boat Ramp		✓																										
Croft Ferry Road Boat Ramp	✓	✓																										
Davis Ferry Dirt Ramp		✓																										
Dub Parker Boat Launch	✓	✓									✓	✓										✓	✓	✓		✓		
Fitts Ferry Road Boat Ramp		✓																										
Greensport Marina	✓	✓	✓				✓	✓		✓		✓		✓	✓	✓					✓	✓				✓		
H. Neely Henry Tailrace Area	✓										✓																	
Haney Road Boat Ramp		✓																										
Hokes Bluff Ferry and Ramp	✓	✓									✓											✓	✓					
Lakeshore Marina	✓	✓	✓				✓	✓		✓		✓		✓	✓	✓					✓	✓	✓			✓		
Mountainview Fish Camp	✓	✓																										
Pee Dee Launch	✓	✓										✓																
Rainbow Landing	✓	✓									✓	✓										✓	✓	✓		✓		
Rainbow Marina	✓	✓	✓					✓		✓		✓		✓	✓											✓		
Ten Islands Historic Park	✓	✓									✓	✓				✓					✓	✓	✓			✓		
Tilson's Bend Boat Launch	✓	✓										✓																
Tommy's Marina	✓	✓	✓					✓				✓		✓	✓						✓					✓		
Visitors Center	✓																											✓
Willow Point Marina	✓	✓	✓	✓				✓		✓		✓		✓	✓	✓					✓	✓	✓			✓	✓	
YMCA Camp	NA																											

Source: FIMS, unpublished database; APC, 1999; Carto-Craft Maps, Unknown

Source: Alabama Power and Kleinschmidt Associates, 2000, *Initial Information Package for the Henry Development FERC No. 2146*

APPENDIX C: YEARLY MAXIMUM FLOOD DATA SINCE 1891 FOR THE COOSA RIVER AT GADSDEN, ALABAMA

02400500 COOSA RIVER AT GADSDEN

LOCATION.--Lat 34°00'37", long 86°13'34", in NW$^1/_4$ sec. 10, T. 12 S., R. 6 E., Etowah County, Hydrologic Unit 03150106, on Forrest Avenue in Gadsden, 1.5 mi upstream from Big Wills Creek, and at mile 174.8.

DRAINAGE AREA.--5,805 mi^2.

GAGE.--Water-stage recorder. Datum of gage is 485.97 ft NGVD 29.

REMARKS.--Since December 1949, flow regulated by Allatoona Reservoir and since April 1961, by Weiss Reservoir.

Water year	Date	Discharge (ft^3/s)	Gage height (feet)	Water year	Date	Discharge (ft^3/s)	Gage height (feet)	Water year	Date	Discharge (ft^3/s)	Gage height (feet)
1886	Apr. 6	115,000 [27]	37.90	1928	Apr. 24	37,800	20.79	1966	Mar. 6	46,800	23.61 [2]
1891	--	52,000	24.60 [5]	1929	Mar. 17	53,500	24.58	1967	Aug. 27	40,100	--
1892	--	76,000	30.80 [5]	1930	Nov. 17	58,100	25.76	1968	Jan. 12	48,300	24.19
1893	--	46,000	22.60 [5]	1931	Nov. 18	39,500	20.28	1969	Feb. 10	37,400	22.84 [2]
1894	--	26,000	14.40 [5]	1932	Feb. 5	51,000	23.86	1970	Mar. 23	47,300	23.89
1895	--	42,000	21.50 [5]	1933	Jan. 3	72,900	30.30	1971	Mar. 5	42,000	22.98
1896	--	31,000	17.20 [5]	1934	Mar. 6	46,400	23.30	1972	Jan. 12	46,100	23.52
1897	--	48,000	23.40 [5]	1935	Mar. 14	38,500	20.50	1973	Mar. 20	44,000	23.02
1898	--	47,000	23.10 [5]	1936	Apr. 11	76,900	31.13	1974	Apr. 6	48,800	23.84
1899	--	57,000	25.90 [5]	1937	Jan. 5	55,800	26.16	1975	Sept.25	43,300	--
1900	--	49,000	23.60 [5]	1938	Apr. 14	57,200	26.63	1976	Apr. 1	49,200	24.19
1901	--	48,000	23.50 [5]	1939	Mar. 7	42,000	21.82	1977	Apr. 6	54,000	27.26
1902	--	51,000	24.40 [5]	1940	Mar. 16	33,400	18.55	1978	Nov. 8	40,300	23.54
1903	--	48,000	23.30 [5]	1941	July 9	24,700	15.00	1979	Apr. 14	56,100	27.45
1904	--	17,000	10.70 [5]	1942	Feb. 19	43,500	22.28	1980	Mar. 28	58,600	--
1905	--	40,000	20.50 [5]	1943	Dec. 30	59,100	27.14	1981	Feb. 17	53,900	--
1906	--	56,000	25.80 [5]	1944	Apr. 1	51,300	24.60 [2]	1982	Jan. 18	48,400	--
1907	--	41,000	21.10 [5]	1945	Feb. 17	34,800	19.10	1983	Mar. 4	45,300	--
1908	--	42,000	21.50 [5]	1946	Feb. 16	71,300	30.20	1984	Aug. 1	47,400	--
1909	--	64,000	27.90 [5]	1947	Jan. 25	73,000	29.60 [2]	1985	Feb. 6	27,400 [E]	--
1910	--	33,000	17.90 [5]	1948	Feb. 18	52,200	25.41 [2]	1986	Feb. 19	20,900 [E]	--
1911	--	44,000	22.00 [5]	1949	Dec. 4	67,400	28.34 [2]	1987	Mar. 3	37,600	--
1912	--	52,000	24.50 [5]	1950	Mar. 17	50,700	--	1988	Jan. 21	25,700	--
1913	--	46,000	22.50 [5]	1951	Apr. 1	64,600	28.90	1989	Mar. 7	46,400	24.06
1914	--	37,000	19.50 [5]	1952	Dec. 24	42,900	23.22 [2]	1990	Feb. 22	61500	--
1915	--	44,000	21.90 [5]	1953	Jan. 11	44,600	22.20	1991	Feb. 24	37200	23.59
1916	July 15	85,000	32.70 [5]	1954	Jan. 25	47,200	24.20 [2]	1992	Feb. 28	31100	23.04
1917	--	57,000	26.10 [5]	1955	Feb. 8	41,900	21.30	1993	Jan. 13	32300	22.83
1918	--	47,000	23.10 [5]	1956	Apr. 18	33,500	19.20	1994	Mar. 30	37700	--
1919	--	49,000	23.70 [5]	1957	Feb. 6	47,600	23.20	1995	Mar. 11	39200	--
1920	--	65,000	28.30 [5]	1958	Nov. 22	36,400	19.66 [2]	1996	Feb. 3	48400	--
1921	--	69,000	29.30 [5]	1959	Feb. 15	28,700	16.90	1997	May 5	--	24.38
1922	--	56,000	25.80 [5]	1960	Mar. 5	31,400	17.40	1998	Oct. 26	--	25.06
1923	--	40,000	20.60 [5]	1961	Feb. 26	74,300	30.61	1999	July 14	--	22.94
1924	--	48,000	23.50	1962	Dec. 19	52,600	26.22	2000	Apr. 5	--	23.87
1925	--	52,000	24.50	1963	May 1	48,400	25.85	2001	Mar. 22	--	23.40
1926	--	49,000	23.60	1964	Mar. 28	52,700	26.01	2002	Mar. 31	--	23.58
1927	Dec. 29	41,400	23.60	1965	Mar. 29	42,000	22.56 [2]	2003	May 8	--	24.46

Source: Hedgecock and Feaster, 2007, *Magnitude and Frequency of Flood Events in Alabama, 2003*

VITA

Willis Scott Estis was born in Gadsden, Alabama, and graduated from Gadsden High School in 2001. Following in the footsteps of many family members, he enrolled at the University of Alabama in Tuscaloosa and began classes in the fall of 2001. Despite spending too many nights in Tuscaloosa's entertainment district known as "The Strip", Willis achieved good grades and graduated with a Bachelor of Science degree in environmental science with a minor in geography in December of 2005. He enrolled at Louisiana State University in the fall of 2006. Willis will receive his Master of Science degree in environmental sciences from Louisiana State University in December of 2008. Roll Tide.